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It is a rather interesting sight to watch the efforts of a short motorman when he attempts to hold in the circuit-breaker with one hand, and manipulate his controller and ring the gong, all at the same time. The fact that the circuit-breaker is installed to prevent excessive currents from passing through the motors adds zest to the exhibition.

It is fairly safe to say that in the future no establishments will be equipped by any other than the electric drive for the greater part of the work. It may not always be advisable to use an independent motor for each tool, and it is also a question as to how far variation in speed should be provided for. Each factory presents a special problem which can only be solved by one familiar with its needs, but the general principles are the same in all. The output of the factory must be as large as possible, both as regards the tool and as regards the operator, and in accomplishing this the electric motor stands preeminent.

THE FIRE HAZARDS OF OIL-COOLED TRANSFORMERS.

Not long since some question was raised as to the fire hazard introduced into an electric station by the oil used for cooling and insulating large transformers. The current issue of the *Journal of Electricity, Power and Gas* gives an account of a recent fire which entirely destroyed the plant of the Helena Light and Traction Company, and throws some light on the risk involved in the use of oil for insulation.

After the fire was over, an examination brought to light three oil-filled regulators behind the ruins of the marble switchboard. These were found to be in perfect condition, except for handles and leads which had been burned off and which can be replaced at a cost of about two per cent of the value of the regulators. Next, three Hartford constant-current arc light transformers of the oil-filled type were removed from the ruins. The oil was withdrawn, the coils and cores examined and found to be uninjured, and five days later they resumed their regular duty of lighting the streets of the city of Helena.

The plant contained six 150-kilowatt high-tension transformers. These were erected on a wooden floor which burned through and dropped four into a pit. The oil spilled out and took fire, and the resulting conflagration certainly put the remaining two transformers to a severe test. In spite of this, these two transformers were not materially injured, except by water. The covers of all had been removed to facilitate cooling, as they were running overloaded. Had these six transformers remained in an upright position, and had the covers not been removed, they would not have suffered.

From this it would seem that the danger due to the oil used in transformers is slight. There was no explosion, as had been feared, even under these severe conditions. In fact, the oil acts as a protection, and if transformers and other devices in which oil is used are mounted on masonry, there is practically no danger introduced by the oil. The loss of the Helena station is much to be regretted, but the lessons taught by the fire are very valuable.

THE INTERSTATE INDEPENDENT TELEPHONE CONVENTION.

Next week there will gather in Chicago one of the most important organizations connected with the development of independent telephony. Present indications give marked evidence that in point of numbers of attendants, and in interest, this will be the best convention which the independent telephone interests have ever held.

Nine states are represented in this organization. These are Ohio, Kentucky, Indiana, Illinois, Missouri, Iowa, Minnesota, Wisconsin and Michigan. Over three thousand exchanges, representing the most modern of independent telephone interests, are embraced in these states. The representatives of these exchanges, who will be in attendance at the convention at Chicago, are men who have learned the lessons which the struggles of early independent movements have taught. The questions that will be brought to their attention for elaboration and discussion will be practical, and the interchange of opinions and conclusions will not fail to be of benefit.

Chicago is the conceded Mecca of independent telephony, both from a commercial and manufacturing standpoint. Here are located the permanent headquarters of many prominent manufacturers of telephone apparatus and accessories, and to this point will journey, for the purpose of coming in touch with the exchange representative, many others scattered throughout the United States.

Not a little of the credit for the success which independent telephony has known within the very recent past is due to the manufacturer. There was a time when independent movements were seri-

ously handicapped by the want of efficient apparatus. To-day, there is no such complaint existent. The manufacturer has spent every effort in the endeavor to build apparatus which shall be as nearly electrically and mechanically perfect as possible, and one of the conceded factors in the rapid increase of profit-making independent systems has been the cooperation of the manufacturer of telephone apparatus.

The Interstate Independent Telephone Association was organized less than a year ago, the first formal meeting being held in Chicago on April 9, 1902. At this meeting was recognized the need for such an organization, and a future of great usefulness was prophesied from the beginning. The gathering at Chicago will no doubt witness, as indicated by the enthusiasm which is apparent at the present time, the wisdom of this prediction.

ELECTRICITY FROM TIDES.

A scheme has been proposed for obtaining electricity for use either at the central station or among a special class of consumers in the neighborhood of Dundee, Scotland, in connection with the docks of that town.

If the plan should be adopted, the docks would cease to be used for the purpose for which they were designed, and would simply be reservoirs into and out of which the tidal water would flow, driving turbines. It is stated that for sixteen hours per day two hundred and twenty horse-power could be obtained in this way from the two docks. It must be remembered, however, that the period each day during which power can be obtained varies with the state of the tide, and that it is most unlikely any consumer of power could be found who would require it only during the sixteen hours in question.

A London contemporary—the *Electrical Engineer*—states that to compete with steam this power would have to be sold at about two cents per Board of Trade unit; and when it is remembered that this use of the docks would prohibit their use as docks, it does not seem probable that the scheme would be successful.

The use of the tides for operating motors has been suggested many times and has been tried on a few occasions; but the uncertainty of the system would cause it to be looked upon with doubt by most engineers. Therefore, it hardly seems probable that the plan, as outlined for Dundee, will actually be put in operation.

ELECTRICAL SYSTEMS ON SHIPBOARD.

In a paper read recently before the Society of Naval Architects and Marine Engineers, Mr. F. O. Blackwell argued for an increased use of electric motors on ships, particularly naval vessels.

In the system proposed by the author three-phase generators are driven by steam turbines. Except where very complete control over the speed is necessary, induction motors are to replace the inefficient steam auxiliaries. For moving the turrets the Ward Leonard system will be used, as it has been found satisfactory in this application. This system is also proposed in place of the steam steering gear now found on these vessels.

At other points, when more than one speed is called for, variable speed induction motors can be used, the changes in speed being secured by means of a rheostat in the secondary or by commutating the primary winding so as to obtain different polar groupings.

To simplify the lighting, it is suggested that this load be carried on one phase of the system. This will also enable the potential of the lighting circuits to be kept constant, irrespective of the motor load, but will make necessary the use of a special potential regulator. The lights take but a small part of the total output of the plant.

The reciprocating boiler feed pumps can be replaced by centrifugal pumps, as these are now made to deliver water at much greater pressures than are yet used in boilers. These will be driven by induction motors.

The advantage claimed for this system is that by adopting the steam turbine sets a plant with sufficient capacity to operate electrically all the auxiliaries can be installed in one-third the space now required and with one-half the weight of the direct-current systems now generally employed. An alternating system is advocated, as it is held that alternators are better suited than direct-current generators for the high speeds obtainable with the steam turbine as the prime-mover. This system would not be as simple as a two-wire, direct-current system so far as the wiring is concerned, and regulation for lighting would probably be more troublesome. Moreover, induction motors lose in simplicity and, with rheostatic control, in efficiency if variable speed must be provided for.

There are direct-current generators designed to be driven by steam turbines, but how these compare with the turbine-driven alternator in weight no data are at hand to show. The turbine seems very suitable for either system for installation on ships. However, there will be new problems to be solved, such as preventing troubles from the gyroscopic action of the turbine as the ship pitches.

There can be little doubt that the steam auxiliary will be abandoned some day for the electric motor, but the Navy Department is very conservative and makes haste slowly in realizing the benefits of electrical systems and apparatus, and no one can say to-day which system will be chosen.

DIFFERENCES IN PRACTICE.

Occasionally a striking illustration of difference in practice comes to light. A recent number of the *Electrotechnische Zeitschrift* states that at the National Congress of Electrotherapeutics and Radiography, held in Berne, September last, excellent exhibits of Rœntgen X-ray apparatus were shown by European makers. The German maker invariably used an induction coil to obtain the high potential necessary to excite the tube. On the other hand, in the French and Italian equipments, an influence or static machine was used. It is stated that the effect of the most powerful of these static machines is scarcely equal to that of the smallest induction coil exhibited, while the cost of the latter was only one-half that of the former.

It is rather remarkable that in these countries in such close contact, with many facilities for the exchange of ideas and experiences, means differing so widely

should be used to obtain the same end. If the static machine has any advantages over the induction coil, its use may be justified. This should not be a difficult matter to determine, and it seems surprising that it has not already been done. While this matter is not of great importance, it is nevertheless worth while proving which apparatus is the better. The incident serves to illustrate the point we made above, that methods are far from being standardized in many branches of applied electricity.

REFUSE DESTRUCTORS.

The advisability of attempting to utilize the heat given off from refuse destructors has been made a subject of discussion again in Great Britain by a paper read by Mr. W. F. Goodrich before the Manchester Section of the Institution of Electrical Engineers.

The great objection to refuse destructors seems to be the difficulty in preventing offensive odors from escaping through the chimney. This can only be done by keeping the furnace—or cell, as it is called—always at a high temperature. There are several ways of accomplishing this. Two or more cells are placed side by side, with a common combustion chamber. These are charged one at a time, and in this way the temperature is maintained fairly constant, and much higher than could be were the cells independent. In another type of cell described, the grate surface is divided into four compartments which are charged in practically the manner just described.

In all types of cell it is advisable to pre-heat the air. The high average temperature which can be obtained in properly constructed destructors makes it possible to save a great deal of heat which would otherwise be carried off in the gases. From figures given by Mr. Goodrich, over one and one-half pounds of water from and at two hundred and twelve degrees Fahrenheit can be evaporated per pound of refuse.

In this country we have done very little in the matter of refuse destructors, and we are generally satisfied if our garbage is, in the first place, dumped out of sight; what becomes of it afterward we do not care. This can not be considered a strictly scientific way of disposing of our waste. Much of the material thus cast away might be converted into a fertilizer and this would be the best solution of the problem if it could be made self-paying. Assuming this not to be possible at this time, the refuse destructor should be seriously considered. We go to great expense to save a few per cent of our coal at power stations, but we throw away without a thought daily great quantities of a poor grade fuel, to say nothing of the unhygienic conditions which may be caused by its decomposition.

ELECTROCHEMICAL PHRASEOLOGY.

Now that the use of certain electrical terms is under discussion, it seems well to call attention to another expression which is current in electrochemical literature and which doubtless is the cause of much confusion among students of this branch of chemistry.

In describing the action of the galvanic cell it is customary to state that the metal of the anode passes into solution and assumes a positive charge. At the cathode the metal ions are deposited in metallic form and here, it is stated, they give up their positive charges to the circuit. In turning this idea of the action of the electrolytic cell over in his mind, the student has difficulty in understanding the apparently inconsistent behavior of the ion. This passes into solution giving up energy, and at the same time assumes a positive charge. At the other end of the cell the ion gives up its positive charge and at the same time receives sufficient energy to allow it to appear in the metallic state. This confusion does not seem necessary.

Even among those electrochemists who do not accept the new theory of electrochemistry, it is customary to speak of the ions in the solution as carrying positive and negative charges. If a neutral body gives up a negative charge, it then remains positively charged, and in the same way a body having a positive charge can receive energy in the form of a negative charge and become neutral.

Would not this statement of the reactions cover the case and avoid the apparent paradox suggested by the statement that the ions give up charges and receive energy at the same time?

ELECTRICAL DEVELOPMENT IN CALIFORNIA.

Excellent work has been done in California in developing electrical applications, particularly in the utilization of water powers and high-tension transmission. At this distance it is difficult to follow closely all that is being done out there, and for this reason the following information, given by Mr. W. M. Bunker in a recent address in Philadelphia, is very acceptable.

The pioneer work in transmission was undertaken ten years ago, when power was transmitted thirty miles at 10,000 volts, from San Antonio Canon to Pomona and San Bernardino. This, however, was only the beginning, for since then transmission plants have multiplied rapidly, distances have increased, and voltages have gone up. The Edison Electric Company No. 3 has a water-head of 1,860 feet. The Standard Electric Company, of San Jose, is delivering power over a distance of approximately 200 miles. The Bay Counties' Power Company delivers light and power in San Francisco and other cities, over 125 miles.

The electrical transmission of California at present aggregates 100,000 horse-power, and plans are now proposed for developing from 10,000 to 250,000 horse-power on single sites, for transmission to the larger cities within a radius of 100 miles of San Francisco. Within a radius of transmission of 200 miles, there is more than 1,000,000 horse-power available in known sites awaiting development.

Truly, the work of California engineers is something to be proud of. They have broken the records for the distance of transmission and for the height of head utilized. But with all this power available, it looks as though the work had only been begun.

The favorable showing made by the electrically equipped trains of the Manhattan Elevated Railway Company is gratifying, but not unexpected. The cost of operation is fifty per cent of the gross earnings, as compared with fifty-five per cent of the last year, and the number of passengers carried was increased fifteen per cent. This report can not fail to have some effect with those who either are, or should be, contemplating the replacement of steam operation by electricity.

Greater Permanent Progress of the Independent Telephone Industry.

Comments on Cheap Rates and the Cost of Maintenance.

By Fred De Land.

GEORGE ELIOT wrote that "introspection which starts with the purpose of finding out one's own absurdities is not likely to be very mischievous." Now the year 1902 has been a year of introspection, of revision, of fresh resolutions and of reconstruction in the independent telephone field. And though there has been much halting all along the line, the seeming dullness is due to thoughtful self-examination. Yet greater permanent progress has been achieved this year toward placing the independent telephone movement on a sound financial basis, than in any two preceding years.

And with a more intelligent understanding of the many and vexatious problems involved has come a willingness to tolerate the public utterance of views that four years ago would have been declared heretical, and to admit that a man may be an honest independent, even though he holds opinions at variance with the accepted views of a few self-appointed judges. In other words, the viewpoint of independents has broadened, and now there is hope of a successful future.

Compared with previous years, the number of new independent telephone companies organized has been far below the average and only a small percentage of the old companies have increased their personal liability. Yet unto excellent results have independents attained through striving to be honest with themselves and of saying those things which the heart burned to utter.

The year 1902 opened with a "lamentable financial embarrassment in Cleveland" that upset many plans, seriously affected investment in telephone securities, and that led many capitalists to incline toward Mr. Abbott's belief, as stated before the American Institute of Electrical Engineers, that "many of the present (independent) organizations, lacking in experience and strength, located in unpromising fields, will go down with the first monetary stringency, throwing by their ruin considerable disfavor on the financial aspect of telephony. The remaining independent companies will be forced to adjust their rates until such a point is reached as to enable them to become investments of reasonable earning power, and to this end only the most carefully designed, best constructed and shrewdest managed plants can possibly survive."

Involved in that "lamentable financial condition in Cleveland" were outstanding securities having a face value exceeding $24,000,000, and while it did seriously handicap the placing of telephone securities, and is to be deeply regretted, yet it had its bright side. For it started men of affairs to wondering what must be the future of an industry in which one unit could, in the short space of five years, float securities to the amount of $24,000,000, a sum greater than the parent Bell company's total permanent liability nineteen years after the telephone business was started. And it served but to increase the wonder to learn that the unit in question operated only in the northern half of one state. Thus capitalists began to ask: How many more units are there? How profitable is the enterprise? What are its weak points?

But it did something far better than this. It started every thoughtful telephone man to ascertaining for himself whether certain independent doctrines were not only profitless but pernicious. And when a man—even a newcomer in the independent field—starts in to be honest with himself, to separate the wheat from the tares, something is going to drop and some one is going to be heard, cost what it may. Naturally, there has been a continual dropping throughout the year in the form of clear-cut demonstrations of the fallacies that have been foisted on independents in the past. These statements have been publicly made by independents to independents in convention assembled, and refer only to mistakes made by independents, and the evil effects of which would continue until independents honestly analyzed the problems that necessarily face all who enter the telephone field.

While those loyal pioneers, Thomas and Critchfield, Fisher and Dougherty, tried at the Chicago convention in 1899, and since, to point out the dangers that encompass the thoughtless independent touching upon the very points so widely discussed at western conventions during the past twelve months, yet the independents in Iowa were the first to come out and publicly and frankly admit that the independents had "underestimated the cost of maintaining a telephone system, and, consequently, made the rates much too low," that an average allowance of ten per cent per annum for depreciation must be made before the true earning power of a plant could be determined; that "sentiment is no longer the prominent factor that it once was in the independent field, and it is becoming more and more apparent that the company giving the best service and the most courteous treatment will secure the business," and that "great enterprises are the measure of the men who execute them, and they will cost the price, which must be made a part of the work itself." And Iowa recommended "improved construction and equipment" and "consolidation and a larger community of interests of independent companies."

Then Wisconsin came into line and openly declared that "it is a fact that the dangers and pitfalls which menace the success of independent telephone companies in the future are not those created by the warring competition of the Bell company and its allies, but rather by those men connected with the independent telephone companies who seek to control their management by rules inapplicable to the telephone business," and that "the weak point in the independent telephone movement is in the great multiplicity of small companies; consolidation would bring economy in management, economy in the purchase of supplies and economy in construction. Under the present conditions many small companies can be said to have no management whatever," and that "unlike the conditions of ordinary corporations the construction work of a telephone plant is never completed; its capital account can never be closed."

Indiana lost no time in joining hands with those independents who were struggling to be honest with themselves by stating that "telephone territory is such that you can not maintain a claim and not work it." Indiana believes that those who are in the telephone field should develop their own field rather than encroach upon others, and those who desire to enter the business should find new fields.

Indiana believes that the board of county commissioners of the respective counties should be empowered and authorized to grant to any person or persons, or voluntary associations and companies engaged in a general telephone business, the right to construct and maintain telephone lines upon and over the public highways of the respective counties. Indiana "condemns the practice of granting such (traffic) connections other than by explicit written contract in which each company shall have the right to refuse business which shall tend to violate its existing contracts," and "recommends that each independent telephone company refuse connection with such companies as have been organized and are operated in cities, towns and communities already supplied with independent telephone service, and which, after such organization, attack the doctrine of the right to control the telephone business by contract."

Ohio, as a whole, has kept quiet this year. For she has been seriously wondering whether she purchased a gold brick when she rejected the watchful care of the pioneers who tenderly nursed her from infancy to lusty youth, and who often explained the dangers that lurk in free toll service and in local rates of less than $24 and $36 for service in towns, and double that rate in cities, and went coquetting with the more plausible contractors who painted in glowing colors the bonanza that was hidden in the dollar rate. Everything indicates that Ohio is longing for the old love, and scorns the men who palmed off the deadly dollar rate. But she finds that rate a difficult gift to return, yet realizes that it will bankrupt her if she is unable to cast away the burden. For she has more than 200 exchanges where this destructive dollar rate prevails, and many of these exchanges supply service to from 500 to 900 subscribers. And to add to her sorrows, the councils are very slow about granting the desired increase in rates. For is it not on record that the plausible contractor proved that a seventy-five-cent rate was sufficient for residence service? These are some of the reasons why Ohio is not talking this year. She is taking time to think it all out and determine just what struck her. Thought and time and wisdom and silence make a strong team. Ohio may be wearing sackcloth, but she is not sitting in ashes. She's up and doing, but just whom remains to be seen.

But while Ohio as a whole has been quiet, many of the individual units have been industriously striving to clearly portray to their respective councils what a losing investment an independent telephone exchange is at existing rates; that plants that the contractors guaranteed to last from twenty to thirty years are worn out and useless after five to seven years' service; that instead of there being only a nominal depreciation charge of from three to five per cent, from fifteen to twenty-five per cent per annum must be charged off on the old plants, and that the more rapid the growth of the business the slower the profits come in. It must nave been humiliating to take back so many of the statements that were based on the glittering generalities of the contractors, but it was manly to openly admit the mistaken views. Yet the real bitterness must rest in the thought that her loyal lovers long ago explained that this would be the logical outcome. And it was only the bitterness of her biased views that blinded Ohio to the deception that was being practised on every hand. To the coming convention of the Interstate Association Ohio sends this message: "What is true of Cleveland is also true of these other cities. We are not charging enough for the service we give. Here is the whole thing in a nutshell. We did not figure on the enormous increase in business. Every new telephone that is put in adds to our indebtedness and makes operation more costly. It is a fact that we could cut off 2,000 subscribers from our list and make money, and could make more money if we cut down our list to 5,000."

How different that sounds from the message Ohio sent to the same association last April, when she claimed that while the Cleveland plant "has been made the 'trial horse' for the whole independent system, it has been the plant on which nearly all experiments with new schemes and new apparatus have been made, experiments which have been costly to the company, but the benefit of which the other independent companies have reaped." Yet, notwithstanding these costly experiments, "the result of the company's operation is that the active productive use of one-half of its plant is actually paying its operating expenses, maintenance, fixed charges and a surplus of $35 a year on a total investment twice that which is active and producing."

And there are disappointments and deficits down in Maryland. Baltimore faced a bitter dose, but it was manfully swallowed. Think of the courage it required for an independent to go before the city council and publicly place on record that "the telephone business has been one of continued growth and experiment. It has been found that business can not profitably be done in a large city under the present conditions and that the present conditions are not such as make the charges bear equitably upon the small business house and the small tradesman."

If that is not rank heresy, what is? For an independent to even intimate that flat rates are inequitable, and that a profitable business can not be done in a large city with flat rates, presages—what?

Baltimore also placed on record that "it has been found that, contrary to almost all other kinds of business, the operating expenses per telephone increase with the number of telephones in service, for the reason that, as the number of telephones increases, the amount of use to which each telephone can be put is correspondingly extended so that the operating expenses per telephone are increased."

Holy smoke! To think of an independent, a genuine independent, too—up to the latest advices—placing on record as independent experience a literal copy of the old Bell arguments that have been smashed to smithereens by every newcomer in the independent field. What does it all mean? Must we all recant?

And in "a frank and full statement to the public of its position in regard to the readjustment, which it has made, of its rates," the Maryland company partakes of a delicate dish of crow after this fashion: "The great and unexpected growth of the business, however, with the complications incident to conducting a telephone business in a large city like Baltimore, makes it necessary to revise the rates in order to enable the company to continue to furnish a high-grade service, to increase the number of its subscribers as contemplated, and to put in force lower rates to attract the small users who can not now afford a telephone."

Wherein does that statement differ from the Bell argument used in the Chicago rate suit, or in the Washington case? Macaulay said that "a line may be stolen, but the pervading spirit of a great poet is not to be surreptitiously obtained by a plagiarist." And as the Bell will necessarily have to use several lines out of this Maryland argument the question very probably arises, Will the independents now hurl the awful charge of plagiarism at the Bell?

Truly it has been a year of surprises from every point of view; a year of ceaseless probing after the truth; a year of doubt and distrust; of reexamination and revision of the so-called "facts" of the

contractor that time has shown are only a mockery, a delusion and a snare.

Yet who can the independents blame but themselves? The very truths that all are now promulgating so loudly have been in type for ten years or more, and have been discussed at every meeting of the National association since 1898. The truths that Maryland presented to the council were clearly explained at the Chicago meeting in June, 1899, by Mr. Critchfield. And never were words spoken more pregnant with truths than the impressive but kindly caution he gave to all new independents in his informal talk at the banquet following that convention. Yet every man who has honestly tried to present these truths fairly at association meetings has been frowned upon as one whose motives were inimical to the growth of the movement, while they who could indulge most freely in vitriolic denunciation of the Bell were welcomed and honored. And while the latter type of independents could not entirely control the association, they did develop sufficient strength to show how easily some men may be persuaded to believe in the purity of the motives of men whose sole aim is to rule or to ruin.

Many an independent who saved his $25, his $50 or even $100 by withholding his support from the National association now regrets his stupid penny-wise and pound-foolish false economy. Yet every independent who appealed to the National association for guidance or protection received the most thoughtful consideration, whether he was a member or not.

Durability of Submarine Cables.

A section of the submarine cable between Cienfuegos and Santiago, in the Caribbean Sea, has recently been raised, with some very interesting results. The cable was manufactured in 1873, and laid off Cienfuegos, Cuba, in 1881. Some few months ago a question arose as to the durability of cables covered with india-rubber, as in this case, and it was decided to raise the Cienfuegos cable and subject it to tests. The line was picked up in 1,350 fathoms of water in April last, and received at the works of Messrs. Hoopers, at Millwall, in June. The tests of this core showed that after twenty years' submersion it was still in perfect electrical condition. An examination of a foot specimen proved that the insulation was in good mechanical condition, and that the copper conductor had not suffered from the attacks of any sulphur in the rubber.

THE AMERICAN TYPE DIESEL ENGINE.

This form of motive power which is being introduced to the American market by the American Diesel Engine Company, of New York, is attracting much attention. A brief explanation of this interesting form of engine is therefore timely.

The essential principle upon which this engine operates, depends upon two natural laws which can not fail. The first is that it is impossible to compress air without increasing the temperature of the air under compression. The second is that if oil is introduced into air at a certain temperature or above, it must ignite and consequently burn. The degree of compression used in the Diesel process heats the air to about 800 degrees Fahrenheit, a temperature at which crude oil burns completely without residue in the presence of a sufficient amount of air.

The Diesel engine does not operate by an explosion as is the case with the ordinary gas or internal combustion engine of other types. There is no mixture of combustible elements in the cylinder excepting at the moment when the combustion is intended to begin. There is no explosion and there are no ignition devices of any description, the machine being a simple caloric or heat engine, using air as a medium of expansion instead of steam. Steam has received heat from the fuel at the boiler. Air in the Diesel process receives heat direct from the combustion of oil-fuel mixed with the air in the working cylinder.

The engine operates on the Otto cycle or four-stroke principle, the first stroke filling the cylinder full of air at atmospheric density. The second stroke compresses the air to about thirty-five atmospheres. At the point of highest compression, the air is practically in an incandescent condition. Just at the reversing point in the stroke of the piston a certain quantity of oil is sprayed through an atomizer in the shape of mist, but not vapor. This oil is immediately ignited and burns slowly through a limited portion of the stroke. The expansion of the air and gases completes the third or working stroke and the fourth stroke ejects the gaseous products of combustion, clearing the cylinder for a repetition of the cycle.

The economy of this engine is claimed to be very great as compared with any other form of motive power. That this may be true will at once be recognized by those familiar with the thermodynamic requirements for high efficiency.

In order to make the nearest possible approach to the perfect Carnot cycle, the following conditions must be complied with:

First—"The highest temperature of combustion must be produced, not by and during combustion of the fuel, but before and independently of it, wholly by mechanical compression of pure air alone."

Second—"Then a small quantity of the finely divided combustible must be introduced into a large excess of highly compressed and heated air in such a way that only slight increase of temperature is caused by the ignition of this charge, while the heat generated by the gradual combustion is immediately converted into work by the expansion of the air and products of combustion."

These conditions are almost ideally met in the Diesel engine; hence the claimed results are rational. Where the best steam plants convert only about ten per cent of the total heat of the fuel into work, the Diesel engine is said to convert from twenty-five to thirty per cent and this in the smallest sizes as well as larger ones. Furthermore, the range of best economy extends over a large part of the entire power, whereas in the steam engine this range is limited to a very small part of the entire power.

Regardless of the size of the unit, the consumption of fuel will not exceed 0.5 to 0.6 pound per brake horse-power per hour, when the engine is running within its economical range; or, more particularly speaking, a 100 brake horse-power engine running one hour at its most economical point will use about six and one-half gallons of oil. This same engine, running at fifty horse-power for two hours, will use about seven and one-half gallons, and running at twenty-five horse-power for four hours will use about eight and one-half gallons. It will thus be seen that the economical range is a large part of the whole power range, a great contrast to the steam engine in this respect. In adapting a Diesel engine to a widely variable load, the element of efficiency at different loads may be practically ignored.

As a machine, this engine is as simple as the automatic cutoff engine and less skill is necessary to operate it.

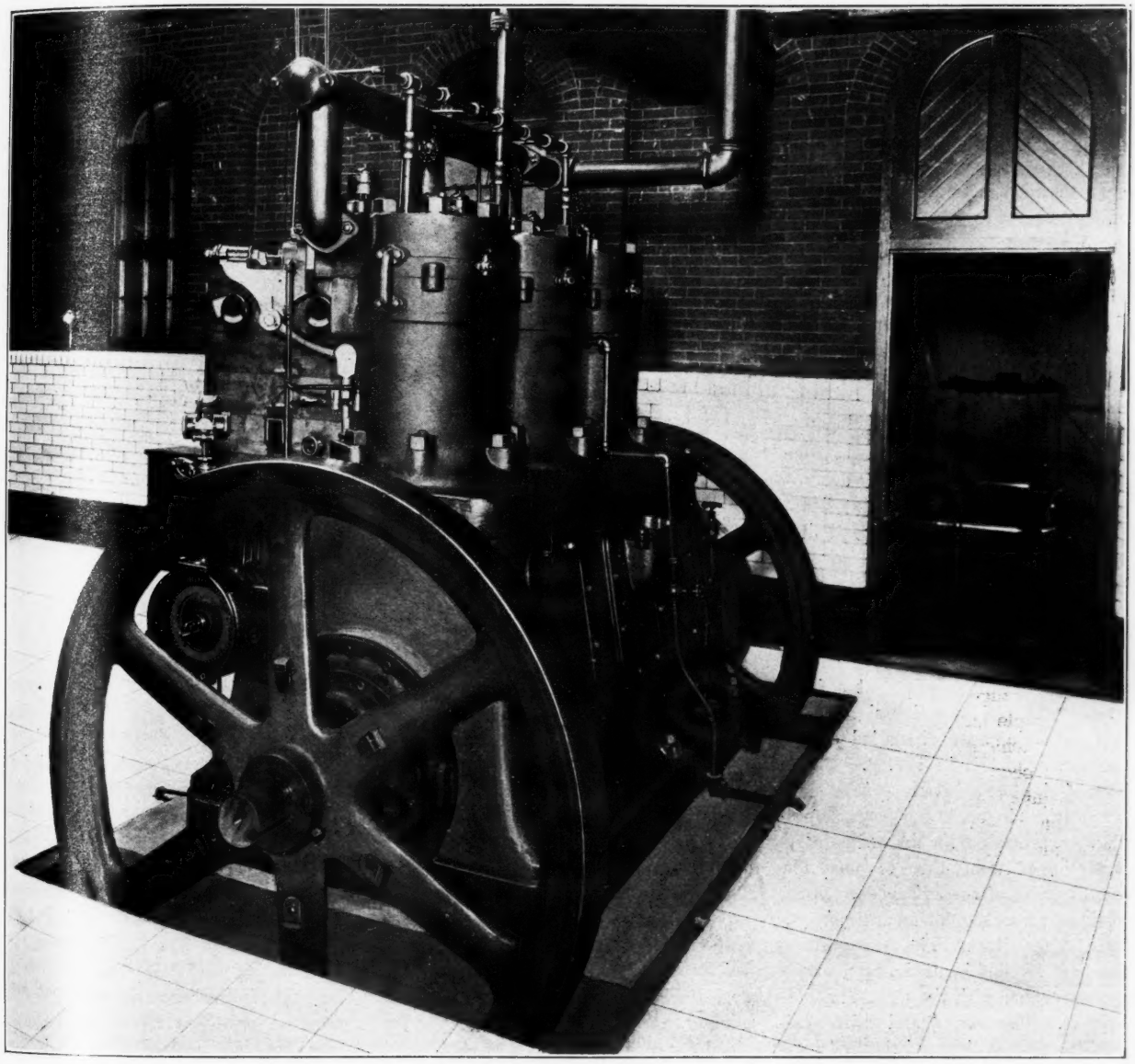
The engine is started with compressed air from a storage tank and ignition is secured during the first revolution. As soon as the engine comes up to speed, the compressed air supply is automatically cut out and the permanent air supply which injects the oil is also automatically thrown into operation. The starting and running are, in all respects, as positive, reliable and free from tricks as is the steam engine. Under ordinary condi-

tions, when working within the economical range, the exhaust from the Diesel engine is clean and odorless. The exhaust pressure is much lower than is usual in engines of the internal combustion type and hence is seldom objectionable if allowed to pass out free. It can, of course, be all the more completely extinguished by a muffler if desired.

Regulation is effected by varying the amount of oil-fuel introduced at each working stroke under control of a governor. Response to this method of control is more prompt than in a steam engine; hence if three or more cylinders are used (on account of there being only one working stroke in four in each cylinder) the Diesel regulation exceeds that possible in the steam engine. Another result of this method of regulation is that any number of engine units can be controlled from one governor so that practically absolute synchronism of running may be had.

These special qualities show at a glance the adaptability of such an engine to electric service. In addition to meeting in a high degree the requirements of central station and isolated installations, it is believed by the introducers of this engine that it affords the best solution of the long-distance traction problem. It is submitted that Diesel generating units can be used in frequent substations along any railway with far better economy than is possible with high-tension current from a central station and transforming substations. Certainly many of the present difficulties of that method would be done away with. The Diesel substation would require no more attention than the present transforming stations. One skilled engineer-electrician could attend to quite a number of stations by having only an oiler on duty at each.

The accompanying illustration shows a three-cylinder Diesel engine which has been erected at the George H. Corliss steam engine works at Providence, R. I. Diesel engines have operated these works for the past six months and have shown an economy of seventy per cent in fuel consumption as compared with coal. They use Texas crude oil. The works of the American Wheelock Engine Company at Worcester, Mass., are operated with the Diesel engine and show similar results.



THREE-CYLINDER ENGINE, ERECTED AT THE CORLISS STEAM ENGINE WORKS, PROVIDENCE, R. I.

The entire works of the American Machine and Ordnance Company at Bridgeport, Ct., are equipped with the Diesel engine, and the first shipment of these engines is being made to the works of William Cramp & Sons at Philadelphia, Pa. The Manhattan Transit Company, New York city, has secured the exclusive rights for the use of the Diesel engine for the state of New York, a complete plant being in operation at Station A, 899 Second avenue, New York city.

Memphis Telephone Company's Exchange System.

THE Memphis Telephone Company, of Memphis, Tenn., placed its new and modern telephone system in operation on March 29 last. The exchange has been in operation since that date and is said to be giving excellent service. The operating is prompt and the transmission satisfactory. Memphis is a growing and prosperous commercial centre, and is the largest city in Tennessee, its population at the last census being over 102,000. The Memphis Telephone Company is progressively managed and controls the telephone situation in Memphis and surrounding territory, at least so far as the independents are concerned.

The central office and main exchange building of the Memphis company is located at 82-84 Monroe street, and consists of a handsome three-story building, approximately 40 feet wide by 100 feet deep. Commodious quarters are provided on the first floor for the general offices. All telephone apparatus and space required for the operators' quarters are provided for on the second and third floors. The entire front half of the second floor is utilized for operators' quarters, providing a handsomely fitted-up lounging room, retiring room provided with cots, also bathroom and other necessary toilet accommodations.

The main exchange equipment consists of a relay multiple lamp-line signal, central energy switchboard installed on the third floor, as shown in Fig. 2. Eleven sections of eight panel-boards, three operators' position to each section, are provided, with provision for an ultimate accommodation of twenty-three sections. The present capacity of the switchboard is for 3,360 lines, providing for an ultimate capacity of 7,200 lines. The first position of the first section is used as an annex position provided with the necessary multiple jacks. The second and third positions of the first section and the first position of the second section are trunking positions. Each position in the remaining sections, with the exception of the last position of the eleventh section, is fully equipped for the operation of 120 lamp-line signal subscribers' lines. The last position of the eleventh section is provided as a multiple annex position for the last-equipped operators' position. Each operator's position is fully equipped with fifteen pairs of connecting cords, consisting of double-lamp supervisory signals, likewise the necessary plugs, cords, weights, relays and associated apparatus.

The arrangement of a regular subscriber's section consists of mounting in the upper part of the face of the board 3,400 multiple jacks in blanks of 100, and providing space for the ultimate accommodations of 7,200 jacks. Below the multiple space are installed the trunking jacks for the monitor's, chief operator's and the wire chief's desks, with space for the ultimate number of 240 outgoing trunks. Immediately below this space are mounted the combination answering jacks and lamp-line signals in strips of ten. The jacks and lamps are mounted alternately, so that the answering jacks appear immediately below the corresponding line signals. Three hundred and sixty line equipments are provided for each section. The line-call pilot lamps and ringing supervisory lamps are mounted in the bar immediately below the answering jacks. The plugs and cords are mounted in the key and cord boards in the standard manner. Two operators' jacks are provided for each operator's position.

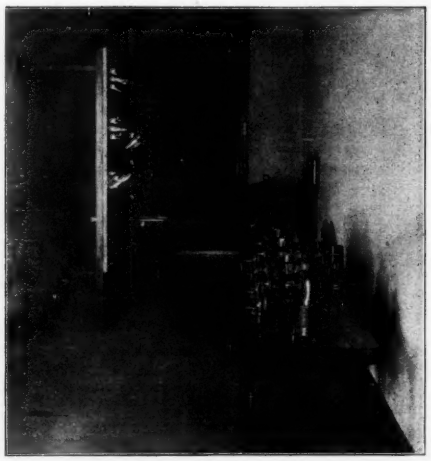


FIG. 1.—POWER SWITCHBOARD, CHARGING AND RINGING MACHINES.

The cabinet work of the switchboard frames is made of quarter-sawed oak and finished in golden oak. The board is illuminated with electric lights mounted directly on the switchboard by means of duplex lamp brackets, providing one bracket between alternate operators' positions. Electric lamps are also provided on the interior of the switchboard to facilitate the proper inspection and care of the switchboard apparatus.

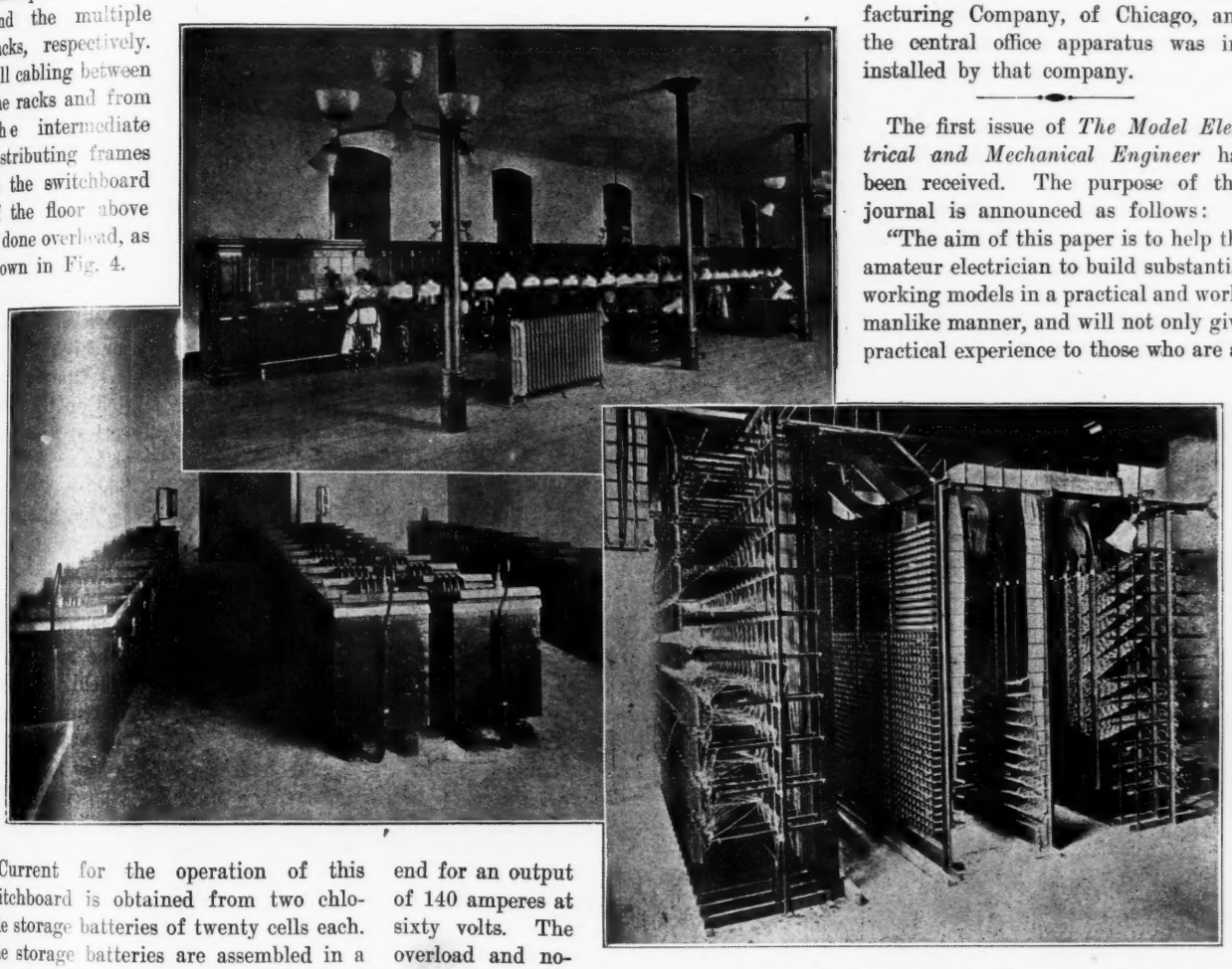
A monitor's desk and chief operator's desk are provided in this room. The cabinet work here is also of quarter-sawed oak and finished in golden oak. The chief operator's desk is equipped with monitor jacks and pilot lamps, one set for each equipped operator's positions, likewise with exchange lines, supervisory lines, intercommunicating lines and cord pairs for the proper operation of the board. The monitor's desk is equipped similarly to that of the chief operator's desk, having the necessary equipment for monitoring each operator, likewise for supervising the service from each position of the switchboard. The manager's desk, installed in the manager's office, is equipped similarly to that of the chief operator and is provided with special intercommunicating lines with the chief operator and wire chief.

A wire chief's desk is installed in the terminal room and is equipped with exchange and intercommunicating lines, likewise trunks to the subscriber board and test lines to the main distributing frame for testing out on the subscriber's lines, and also in toward the switchboard. Testing apparatus is provided for all desirable tests required in the operation of a telephone system.

The auxiliary apparatus for the operation of the relay multiple switchboard is installed in the rear of the second floor of the building. A combination main relay rack and intermediate distributing frame is provided and installed in sections of 800-line equipments each, assembled side by side in such a manner as to make a very compact system of racks and very conveniently arranged for access to any part of the apparatus mounted thereon. The compactness of the arrangement of the relay racks and distributing frames is illustrated in Fig. 4. Five sections of combination racks are installed, providing for immediate assembling of apparatus for 4,000 lines, with necessary provisions for increasing to the ultimate capacity of 7,200 lines. The underground cables are terminated on the horizontal side of the main distributing frame.

Combination lightning arresters of the carbon type and sneak-current arresters of the carbon type and sneak-current arresters of the heat-coil type are mounted on the vertical side of the main distributing frame in strips of 200 pairs each. The relays are mounted on mounting strips of twenty pairs per strip, protected both from dust and inductive disturbances by

means of removable magnetic shields. These relays are mounted in bays of 400 per bay. The intermediate distributing frame is provided for mounting on the multiple side 200-pair strips, and on the answering jack side 100-pair strips, providing necessary means for cross-connecting. The terminal clips are mounted on rubber strips, properly numbered, to correspond to the answering jack panels and the multiple jacks, respectively. All cabling between the racks and from the intermediate distributing frames to the switchboard of the floor above is done overhead, as shown in Fig. 4.



Current for the operation of this switchboard is obtained from two chloride storage batteries of twenty cells each. The storage batteries are assembled in a separate battery room, which is provided with a cement floor properly drained. All battery leads to the battery installation are encased in iron-armored conduit, laid in the cement floor. The general arrangement of the batteries is shown in Fig. 3.

The power switchboard, charging machines and ringing machines are located in the power room, as shown in Fig. 1. The power board is made of Italian marble mounted on an iron frame equipped with a Weston flush-type, double-scale voltmeter, scale 0 to 3, and 0 to 75, for providing means for testing the individual cells, and also the total battery voltage; two Weston flush-type ammeters, one for indicating the charge rate and the second for discharge rate; a six-circuit voltmeter switch; an automatic overload and underload circuit-breaker, likewise the necessary switches, fuses, bus-bars, rheostats and starting boxes required for the operation of the battery plant.

The machines installed for the operation of the power plant consist of two Roth Brothers direct-connected motor-dynamos, the motor end being wound for 500 volts direct current and the dynamo end for an output of 140 amperes at sixty volts. The overload and no-current release starting boxes for these machines and also the rheostats are mounted on the power board described above. A duplicate set of ringing dynamotors, also of the Roth type, is installed. One pair is operated directly on the 500-volt power circuit, and the second pair is supplied by the forty-volt batteries (storage). Each machine is provided with automatic overload and no-current release starting box, and likewise equipped with howler, busy-back and intermittent ringing attachments. The machines are mounted on power tables, arranged conveniently for operation from the power board.

The exchange system is operated under the capable management of the officers of the Memphis Telephone Company, the list of names being as follows: President, Harvey Mvers; vice-president, C. D. Gallowat; secretary and engineer, Frank C. Smith; treasurer, Benjamin A. Adams; general manager, John S. Warren, and cashier and auditor, R. R. Revill. The central office equipment, as well as the substation apparatus, was furnished by the Stromberg-Carlson Telephone Manufacturing Company, of Chicago, and the central office apparatus was installed by that company.

FIGS. 2, 3, 4.—SHOWING RESPECTIVELY THE MAIN SWITCHBOARD, THE BATTERY EQUIPMENT, AND THE INTERMEDIATE DISTRIBUTING BOARD AND RELAY RACKS.

The first issue of *The Model Electrical and Mechanical Engineer* has been received. The purpose of this journal is announced as follows:

"The aim of this paper is to help the amateur electrician to build substantial working models in a practical and workmanlike manner, and will not only give practical experience to those who are at their studies, but will be a great help to those who are already in the workshops."

Among other articles of interest are given instructions for making a dry cell, a telephone and a small steam engine, the latter two with working drawings.

The journal makes a very creditable beginning, and we wish it a long and successful career.

It has already been proposed to utilize the waste heat from smelter slag to generate electric light and power. George Mitchell, of Cananea, Sonora, Mexico, is credited with having offered at Butte, Mont., to furnish the copper plant with free power, and with the surplus to light the city and operate the street railway system.

THREE-WIRE SYSTEM FOR VARIABLE SPEED MOTOR WORK.*

BY N. W. STORER.

At the present time, when the possibilities of the electric motor are being realized and it is everywhere taking its place in factories, machine shops, steel mills, and in practically every kind of industrial enterprise, the type of motor to be used and the best method of applying its power are much discussed topics in engineering circles. In deciding the type of motor to be used it is generally recognized that the alternating-current induction motor has its own particular field; the direct-current and alternating-current motors have a common field, and the direct-current motor in turn has its own special field. In deciding the method of applying the power, the choice lies between a separate motor for each machine and group driving of machines from countershafts driven by constant speed motors.

If individual motors are selected, when variable speed is desired, there is the further choice between the constant speed motor with mechanical speed changing devices and a variable speed motor direct-connected to the machine. In this latter class of work is found the special field for the direct-current motor.

Omitting cranes, street railways, hoists and other classes of service where the series motor with rheostat control is used, we find that variable speed motor work may be divided into three classes:

First—Machines requiring a torque increasing with the speed. Blowers and fans belong in this class. The power required for the machine increases very rapidly as the speed increases, and great care should be exercised in selecting motors for such service. However, as the variation required is usually small, the requirements can be met with standard motors on a single-voltage system. Motors should preferably be compound wound and the speed should be varied by means of a resistance in the shunt field.

Second—Machines requiring a constant torque. In this class pumps and air compressors are the most conspicuous examples. The speed variation required for such service is usually small, and it is generally best and most economical to supply compound motors and to vary the speed by means of the shunt-field rheostat, as in the case of the fans and blowers. A series winding is especially beneficial for this class of work in preventing the heavy fluctuations of current that would take place with a constant speed motor in passing through the different parts of the cycle. A compound motor may be used for this work because a constant speed at any point on the controller is not necessary.

Third—Machines requiring approximately the same maximum output at any speed, or a torque varying inversely as the speed. This class includes most of the machine-tool work where automatically constant speed regulation on any notch of the controller is especially desirable. It is, therefore, necessary to use a shunt motor having good inherent regulation.

It is the last-named class of service that has caused the most discussion. Several companies have entered this field with different systems of variable speed motor control. Some of these companies are able to place their motors on the standard and well-known systems of power distribution, while others seek to introduce special systems. The writer has been interested in the development of the three-wire system for this class of work, and it is the purpose of this paper to describe the operation and advantages of this system as presented by the Westinghouse Electric and Manufacturing Company.

The Generator—The standard Edison three-wire system for general power distribution is so well known that it is unnecessary to describe it. The power station equipment, consisting of two 125-volt generators connected in series with the neutral wire brought out between them, is also well known, and the single-voltage generator with a motor-generator set of sufficient capacity to carry the unbalanced current is used in many places. But the type of generator which is rapidly attaining prominence is the so-called three-wire generator, consisting of a standard direct-current generator designed for the maximum required electromotive force having collector rings connected to the armature winding like a two-phase rotary converter. The leads from these rings are connected to auto-transformers or balancing coils, the middle points of which are connected to the neutral wire. With no external devices whatever, the neutral wire is thus maintained at a voltage midway between the outside wires of the system (see Fig. 1). These generators may be operated in multiple with any standard three-wire system, whether it consists of two machines operated in series, a single-voltage generator with a balancing set, or a double-commutator generator. Any standard single-voltage system may be changed into a three-wire system by adding collector rings to the generator and using balancing coils to support the neutral wire.

The Motor—The standard type of motor is used on this system. If only a small variation in speed is desired, as about two to one or less, only one voltage is used and the speed variation is secured entirely by changing the shunt-field current. If wider variations are required, it is preferable to use the two voltages of the three-wire system. It is necessary simply to make a 220-volt motor connected so that it may be operated on either 110 or 220 volts. The minimum speed is secured on the 110 or low-voltage circuit with full field strength. Any other speed less than double the minimum will be secured on the same circuit by decreasing the field current. All higher speeds are obtained on the 220-volt or high-voltage circuit in the same manner. Operated in this way the motor is started on the 110-volt circuit, having in series with the armature a resistance which is cut out for the first running notch. The speed is increased in successive steps by inserting resistances in the field circuit until the maximum 110-volt speed is reached. Then the controller changes the motor to the 220-volt circuit with a resistance in its armature circuit, and at the same time gives the motor a stronger field. The resistance in the armature circuit is used only in passing to the higher voltage, and is immediately cut out for the first running notch. For higher speeds, resistances are again inserted in the field circuit, as before, until the maximum desired speed is reached.

In this manner a variation in speed of one to six is easily obtained. Greater variations may be obtained if desired, but are not to be recommended except in special cases, as the size and cost of the motor will be so great that larger variations than one to six are hardly to be recommended on any system. The size of motor is determined by the output at the lowest speed, so that unless the maximum speed is excessive the motor size will be very large for the output required if variations even of one to six are required.

OPERATION.

Communication—The operation of motors on this system is most satisfactory. The fact that the speed is increased so much by weakening the field might lead some to think that the commutation would suffer, but such need not be the case. An example will demonstrate the

*A paper read at the 170th meeting of the American Institute of Electrical Engineers, New York, November 21 1902.

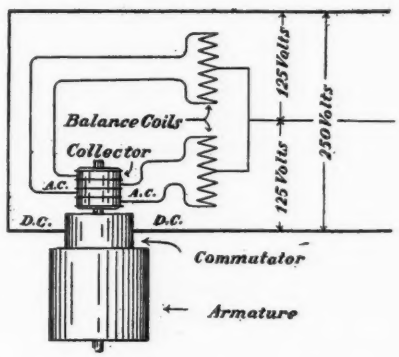
truth of this statement. A certain machine requires a five-horse-power motor to operate it with a speed variation of one to four, say, from 1,500 to 375 revolutions per minute. On the three-wire system this motor will be a standard ten-horse-power, 220-volt motor operating normally at a speed of 750 revolutions per minute. Run with full field strength on the 110-volt circuit, it will develop five horse-power at about 375 revolutions per minute. Operating on this circuit, which has only half its normal voltage, the motor will easily stand an increase of speed of sixty per cent to seventy-five per cent, bringing the speed up to 600 or 650 revolutions per minute. When it is changed to the 220-volt circuit, it will have its normal capacity for ten-horse-power at 750 revolutions per minute; but only half load is required, and it will commutate this as easily at a speed of 1,500 as it would ten horse-power at 750, because both field strength and armature current will be divided by two. From this it may be seen that when the motor is running at full armature current, the voltage is only one-half the normal voltage. When the motor is operating at full voltage, the armature current is only one-half the normal current. If speed variations of one to six are required, they can be secured by a very slight increase in the normal field strength of the motor.

Regulation—The performance of the motor in speed regulation on the separate controller points is very good. As the lowest voltage used is 110 volts, the proportion of voltage lost in resistance of motor, brushes, armature, controller and wiring will be very much less than it would be if a minimum voltage of sixty were used, consequently the speed regulation will be much better. On an extremely slow-speed motor the resistances of the different parts of the circuit play a very important part in the speed regulation. Where a very low voltage is used the speed variation from no load to full load may be as much as twenty per cent or twenty-five per cent.

Controller—The smoothness of operation in changing from one speed to the next is very noticeable. The field strength changes very gradually no matter how suddenly the field resistance is changed. Consequently, there can be no sudden change in speed. In this respect it is better than a system which changes the speed by changing the armature voltage without a resistance in the circuit. At the only point where the armature voltage is changed on the three-wire system a resistance is inserted in the armature circuit, which effectually prevents a sudden jump in speed.

EFFICIENCY.

Motors—The efficiency of the motors, as well as of the entire system, is high. Operating on the low voltage, the motor is at all times running under full load conditions with the efficiency increasing as the speed increases, because the field current and core loss are decreased at the higher speeds. When operating at 220 volts at the minimum speed, the efficiency corresponds to the half-load efficiency of the standard motor. As the speed is increased, the copper loss in the armature remains constant and the field loss decreases so that unless the increased friction overbalances them, the efficiency will increase up to the maximum speed. This is in marked contrast to a motor operated



THREE-WIRE SYSTEM FOR VARIABLE SPEED CONTROL.

on a system supplying a different armature voltage for each speed. To fill the requirements of the above case, a motor of the same weight but normally rated at twenty horse-power, 220 volts and 1,500 revolutions per minute will be required. It will operate at a voltage of about sixty at minimum speed and will there require the normal full-load current of the motor to develop five horse-power. This would be double the current of the motor operated at 110 volts at the same speed; and while the copper loss in the armature and field and the core loss would be about the same as in the other motor, the loss in brushes would be doubled and the loss in controller and wiring very much greater. An increase in the speed will increase the core loss very rapidly, the field will remain constant and the copper loss in the armature will decrease. The efficiency of this motor may be explained by the statement that at the only time the motor is operating under its full-load armature current, it is running at sixty volts and the efficiency is necessarily low. At the maximum speed where the normal voltage of the motor is reached, it operates at only one-quarter load and consequently with a low efficiency. At no point on the curve does its efficiency equal that of the motor on the three-wire system.

Transmission—The efficiency of transmission on the three-wire system is high. Practically all of the current is transmitted at the maximum voltage, as the motors are equally distributed between the two sides of the system for their low speeds. The chances for unbalancing are thus very much less than on a multivoltage system that requires all of the motors to have corresponding speed notches on the same circuit.

Generating Plant—The efficiency of the generating plant is also a maximum. The three-wire generator itself has the same efficiency as the standard direct-current generator of the same capacity. The losses in the balancing coils with fifteen per cent unbalanced load will not exceed one-quarter of one per cent of the capacity of the generator. This gives the most efficient type of three-wire generating apparatus. Comparing it with the complicated generating outfit required for a multivoltage system, shows at once its superiority, both in efficiency and in the amount of attention required in operation.

Economy—The three-wire system is very economical in the wiring. As practically all of the current is transmitted at the higher voltage, the neutral wire may be very small. In this respect, also, it is superior to the multivoltage system. The latter really has two neutral wires, but as the unbalancing is likely to be much greater, they must necessarily be larger than the neutral of the three-wire system, and all the wires would be larger if the same percentage of line loss was maintained. Branch lines to the motor, forming a considerable part of the total wiring system, must be much heavier than on the three-wire system, as there are more wires, heavier currents to be carried and greater losses.

Controller—The controller of the three-wire system is very simple. It is of the standard drum type, designed like a street-car controller. It has the field and armature resistances in the base, making the whole controller very simple and compact.

The advantages of the system described in the foregoing may thus be summed up as follows:

First—Simplicity, not only in the gen-

erating plant, but in the transmission lines, motors and controller.

Second—Efficiency in generating plant, transmission line and motor.

Third—Economy in first cost of generating plant and transmission lines.

Fourth—Constant speed regulation from no load to full load.

Fifth—Smoothness of operation in changing from one speed to another.

These advantages are all easily apparent for work where the motor output is the same at all speeds. In such work the weights of the motors will be practically the same as those on the multi-voltage system. But it is recognized that in work where a constant torque over a wide range of speed is required the multi-voltage system has certain advantages. The motor required will be smaller, depending on the range of speed to be covered. However, for the small amount of such work that is to be done it is better to sacrifice a little in the size of a few motors than to introduce the complicated generating plant and the expensive transmission lines necessary for the multi-voltage system. Motors running on the three-wire system will meet all such requirements. It is only a question of making them large enough.

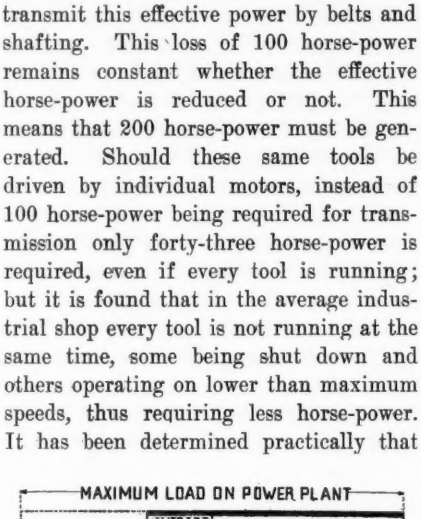
In cases where it is impracticable to have two voltages and a wide range of speed is necessary, a double commutator motor may be used with excellent results. This motor may be built with both ends of the armature wound for the same voltage, in which case they will be connected first in series, then in parallel, giving speed changes corresponding to the speed variations on the three-wire system.

THE OPERATION OF MACHINE SHOPS BY INDIVIDUAL ELECTRIC MOTORS.*

BY R. T. E. LOZIER.

The individually applied motor is now accepted as an established feature of every machine shop. The period of careful investigation, followed by that of cautious probation, is passed, and this type of power application has now been in practical service sufficiently long to provide data that can be studied with profit. These data enable one to make more accurate deductions than were possible in the past, and enable those unfamiliar with the art to undertake its application with greater certainty of results.

From the data that have been collected on power transmission in industrial shops, much of which is to be found in the transactions of the various engineering societies and in the magazines, it appears that if a certain maximum horse-power is required by all the tools of a shop, say, 100 horse-power, it will require at least 100 horse-power additional to transmit this effective power by belts and shafting. This loss of 100 horse-power remains constant whether the effective horse-power is reduced or not. This means that 200 horse-power must be generated. Should these same tools be driven by individual motors, instead of 100 horse-power being required for transmission only forty-three horse-power is required, even if every tool is running; but it is found that in the average industrial shop every tool is not running at the same time, some being shut down and others operating on lower than maximum speeds, thus requiring less horse-power. It has been determined practically that



FIGS. 1 AND 2.

in the ordinary manufacturing establishment the mean effective power is but thirty per cent of the total aggregate effective power which is required when all the tools are running at maximum load. This percentage is termed the load-factor. In the case of belt-drive there is, then, 100 horse-power assumed loss for 100 horse-power effective load; that is, an efficiency of 50 per cent. Applying the load-factor as above, it is found that there is but 30 mean horse-power to use and that it requires 100 horse-power to transmit it, thus giving the real efficiency as only 23 per cent. With the individual motor drive the loss varies with the load. Taking the same load-factor, and assuming 30 per cent as representing the loss incurred by the 30 horse-power effective load, there is but 9 horse-power loss against 100 horse-power with the belt drive. Thus, with individual drive, there is generated 39 horse-power, of which 30 is effective, giving an efficiency of 77 per cent against 23 per cent by the shaft and belt method.

A graphic demonstration of the foregoing is to be found in Figs. 1 and 2.

In a paper read by the author before the New York Electrical Society in November, 1901, it was shown that assuming steam power to cost $36, per horse-power per year (or 3,000 hours), with the shaft and belt system the power would amount to 2 per cent of the cost of the establishment's product. With subdivided motors it would be 1 per cent, and with individually driven motors it would be something less than four-tenths per cent of the cost of the product, so that assuming a plant with an output of $1,000,000 a year, the following statement results:

Method of Drive.	Cost of Power.	Yearly Saving.
Belts and shafting...	$17,000	.....
Subdivided motors...	8,500	$8,500
Individual motors...	4,000	13,000

From such information as the author has been able to obtain since that time, the above figures are correct. These data relate to the average machine shop, and not to establishments run under conditions peculiar to their line of work, and which must be put in a class by themselves, the law of averages being applied to their peculiar conditions.

Assume that in the average machine shop sixty per cent of the motors installed are to have variable speeds. These variable speed motors will have a rated capacity considerably higher than the average amount of power they will be called upon to supply. Concerning the other forty per cent of motors, assume that their rated capacity represents the exact amount of power that they will consume—and this assumption is justified because their speed is not varied. Of the sum of the aggregate rated capacity of the variable speed motors and that of the constant speed motors, thirty-five per cent fairly represents the mean power that all of these motors will be required to furnish, if they are all running at the same time. This mean power, of course, varies with that percentage which the variable speed motors bear to the total installation. If the load-factor of thirty per cent be now applied, which provides for the shut down of tools and reduction in the power due to slow speed, it is found that the average power that must be provided by the generating plant is but 10.5 per cent or the aggregate rated capacity of the individual motors installed. While it is true that sixty per cent of the motors has a much larger rated capacity than is actually required, still this very small

* A paper read at the 170th meeting of the American Institute of Electrical Engineers, New York, November 21, 1902.

amount of power required is an evidence of the remarkable efficiency of the individual drive system. It can not be assumed that this 10.5 per cent is the capacity of the generating plant, because a provision must be made for a maximum condition inasmuch as that percentage represents but a mean condition. However, the system is so efficient that ample margins of, say, 100 or 200 per cent can be applied, which may also provide for "stand-by" purposes. And yet the purchaser, by applying his individual motor system, comes well within that power plant which he would otherwise have to supply to meet the mean conditions of a belted plant, without providing any spares of the latter. The author feels that if it were not for the empirical data presented time would have been wasted by stating an already well accepted fact; i. e., that the individual motor drive is highly efficient and many times more so than the old system of belt transmission, or its modification of using belted motors in groups. It is not claimed that the latter itself has not a sphere of usefulness and a large one, the foregoing being merely a comparison of the relative economy of these different systems. It would not be possible to use the individual motor, if means were not available for successfully varying its speed.

To control the speed of a motor, it is necessary to apply to the armature terminals a voltage corresponding to the speed desired. This can be accomplished in several ways:

The Rheostatic Method—In this case the current is generated at any common source of supply at a fixed pressure or voltage. Before reaching the motor, it is passed through a resistance which is adjusted to consume just so much of the pressure as will reduce the speed of the motor to the point desired. This method has three limitations—*viz:* (*a*) That if the load put upon the motor varies, the portion of the voltage consumed in the rheostat is altered, and this changes the speed of the motor, a thing which may not be desirable; (*b*) the system is inefficient, because that percentage of the voltage which is consumed by the rheostat represents a dead loss; and (*c*) the dimensions of the rheostat necessary to dissipate the energy may reach an inconvenient size. Within its limitations, however, the rheostat system of control can be made very useful. Fig. 3 is a diagrammatic explanation of this system. It will be seen that the motor can not be reduced from its normal speed more than fifty per cent, because below that point the fluctuations in speed, due to variations in torque, are too great.

Multivoltage Method—This method consists essentially in supplying the motor with as many different voltages as are necessary to cover the desired range of speed. In its simplest form this method consists of generators, each adjusted for different potentials. This, however, is not necessary, because it has

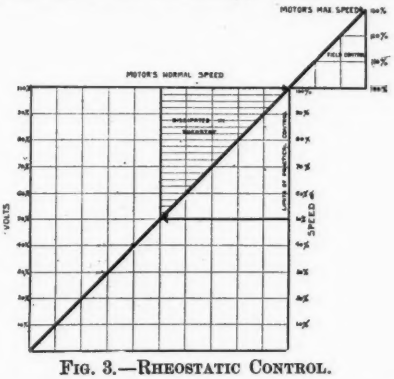


FIG. 3.—RHEOSTATIC CONTROL.

been found that where several motors are involved they will balance up against each other in such a way as to divide among themselves the full voltage, so as to give the respective desired speeds. It is, therefore, only necessary to supply the main generating plant with a small balancer to take up any differences that there may be. By dividing the voltage at three points, there are six possible combinations, which successfully cover the full range of speed as far as general requirements are concerned. The advan-

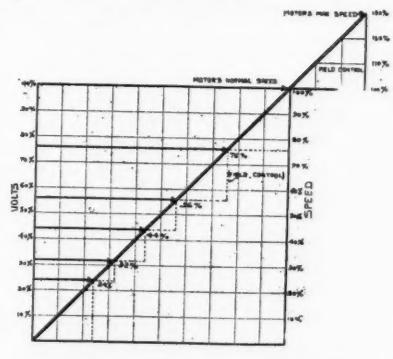


FIG. 4.—MULTIVOLTAGE CONTROL.

tages of this system are: (*a*) That any one of the lower steps can be maintained constantly and quite independent of variations in the torque or load upon the motor—this is absolutely essential to tool operation; (*b*) that the system is highly efficient; (*c*) that appliances to control it are of very small dimensions and convenient to operate (see Figs. 4 and 5).

Special Methods—In this class are to be found various methods which have been devised to meet the special requirements of some one power application. In this class is to be found the teaser system. Fig. 6 has been designed to take care of unusually heavy starting conditions, such as are to be found in large printing-presses. In such cases they can also be operated at a very low rate of speed. The method consists essentially in employing a small motor, which takes current from the main source of supply at the full voltage. This motor drives a small generator wound with large current capacity, which it supplies to the main working motor when the latter starts, but at low voltage, because the speed is very slow. It is because of the latter fact, and further because it is in service for so small a space of time that the apparatus can be made small.

Field Control—The foregoing methods vary the voltages applied to the terminals of the motor armature. There is a method of changing the speed by varying the field strength of the motor and in that way changing the counter-electromotive force at a given speed electromotive force. This has two limitations: (*a*) the first one met with in practice, *viz.*, that as the field of the motor is weakened it goes farther and farther off from its electric balance, and its distress is soon evidenced by sparking at the commutator, due to reaction of the armature upon the weakened field; (*b*) the torque will fail, if the field is weakened beyond a given point. In a motor designed to come fairly well up to the limitations of its normal rating, its speed should not be increased more than thirty per cent. If, however, the motor is large for its work, *i. e.*, underrated, according to commercial standards, then, of course, its speed can be increased until the limiting conditions of speed control, as estabished by its rating, are again reached. Or if the motor is operating at a lower potential impressed upon its armature than that of its normal rating, its speed may be increased over a larger range by weakening its field. But, generally speaking, it is well to understand that field control, while most useful within its limitations, can not be successfully carried beyond such limitations and, generally speaking, such limitations represent an increase of not more than thirty per cent of the normal speed of the motor. It must always be remembered that field control increases the normal speed of the motor and does not decrease it.

In combination with the multivoltage system—which is available for producing certain speeds that remain constant, even with varying torque, throughout the entire range—can be used the rheostatic

control for reducing any one of the fixed speeds down to the next fixed speed. Field control can also be used for increasing any one of the fixed speeds, up to its next graduation. By these means, speed increments as finely divided as one pleases can be obtained, that will carry the speed of the motor from zero to maximum, with high efficiencies and practical constancy at any one point, despite varying torque. The multivoltage is depended upon to form the framework of the speed control, while the rheostatic and field control supply the detailed elaboration, where such may be necessary. The multivoltage is carried throughout the entire plant, usually by two conductors in addition to the two main circuits, while the rheostatic and field control is applied locally as circumstances may require.

Thomas A. Edison marked an important epoch, about seven years ago, when in his great ore milling undertaking he put into operation a principle that had long been accepted by him—that machinery and equipments were cheaper than labor and general expense and that it was better to use up your machinery at a high rate, if by so doing you materially increased your output.

About four years ago the matter of determining exactly the speed limitations of iron working machinery was taken up by a few enterprising engineers and these limits have since then been kept in view with the greatest amount of success. Where before the old thumb rule governed, now the slide rule has taken its place. While labor was bitterly opposed to the principle of the employer inducing his operators by additional incentive, to work up to the highest efficiency—which incentive was withdrawn when that point was reached, and their wages, perhaps, still further reduced should they fall behind—they have been led to recognize the benefits to be obtained by securing to the operator his mean wage, allowing him to share in the benefit gained by his working up to his normal capacity. These methods at present come within two general classifications. I will mention them here, because they are pertinent to the general subject of variable speed control. The first is the premium system, in which the law of averages is applied to past work and the result is taken as a standard for determining what can be done in the future. This determined amount is generally cut down in order to provide for the increased efficiency at which the man is supposed to work. Now, if a man is able to improve upon that time, he is given a pro rata share of the gain. This system is based upon empirical data. The other system is more recent and is known as the bonus plan. The method is as follows: First, the limit of speed and depth of the cutting tool are determined, then the area to be traversed by that tool determines the minimum space of time

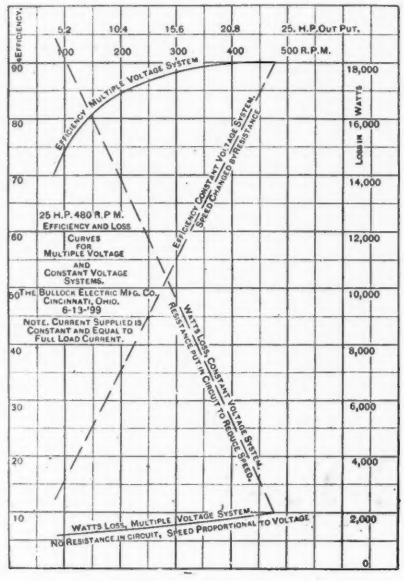


FIG. 5.—EFFICIENCY AND LOSS CURVES FOR MULTIPLE VOLTAGE AND RHEOSTATIC CONTROL SYSTEMS.

in which the tool can traverse it at its maximum cutting speed and depth. In making this calculation, it is assumed that the operator has always available the speed that represents the maximum limitations of the tool. Stability of the machine tool itself, and the capacity of the power transmitted to do the work, must be carefully considered. The operator is given explicit directions

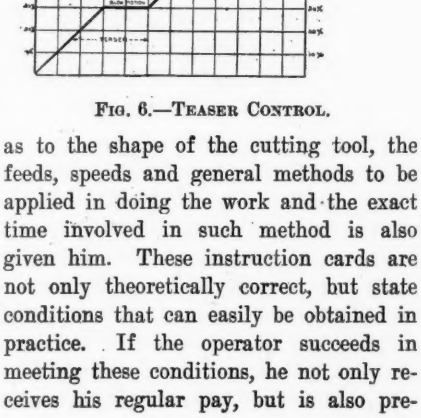


FIG. 6.—TEASER CONTROL.

as to the shape of the cutting tool, the feeds, speeds and general methods to be applied in doing the work and the exact time involved in such method is also given him. These instruction cards are not only theoretically correct, but state conditions that can easily be obtained in practice. If the operator succeeds in meeting these conditions, he not only receives his regular pay, but is also presented with a fixed bonus. With such a method of operation as has just been described, the practical operator immediately recognizes the essential points.

First—He must have a cutting tool that will stand up to the work.

Second—He must have a motive power having a range of speed from which he can always select, and, quickly, the speed that will produce the results expected. This motive power must be able to stand up to its work.

Third—The machine tool must have sufficient strength to stand the strains that may be put upon it.

The limit of high-speed operation is not to be found in cutting tools, or in the ability of motors to successfully do the work and to vary their speed, or to the motors' first cost, but is to be found in the stability of the machine tool itself, which is generally designed to stand the lower strains and the smaller powers required by the old cutting rates. I have prepared a table which I believe fairly well represents what was possible in the way of cutting speeds, four years ago, and what can be readily obtained in practice to-day, provided the machine tool can stand the strain.

CUTTING RATE—REVOLVING.

Material.	By Old Methods. Feet.	New Methods.* Feet.	Cut. Inches.	Feed. Inches.
Cast iron.....	20	60–80	$\frac{3}{16}$	$\frac{1}{16}$
Forged steel, unannealed..	12	40–60	$\frac{3}{16}$	$\frac{1}{16}$
Steel casting...	10	40–70	$\frac{3}{16}$	$\frac{1}{16}$

*Using Novo, Taylor White or First Sterling tool steel.

It is interesting to point out in connection with this table, that at these high-cutting rates a speed range must be provided to allow for the variation in the material itself and therein the variable speed motor, with its large range of easily selected speeds, serves a most important function.

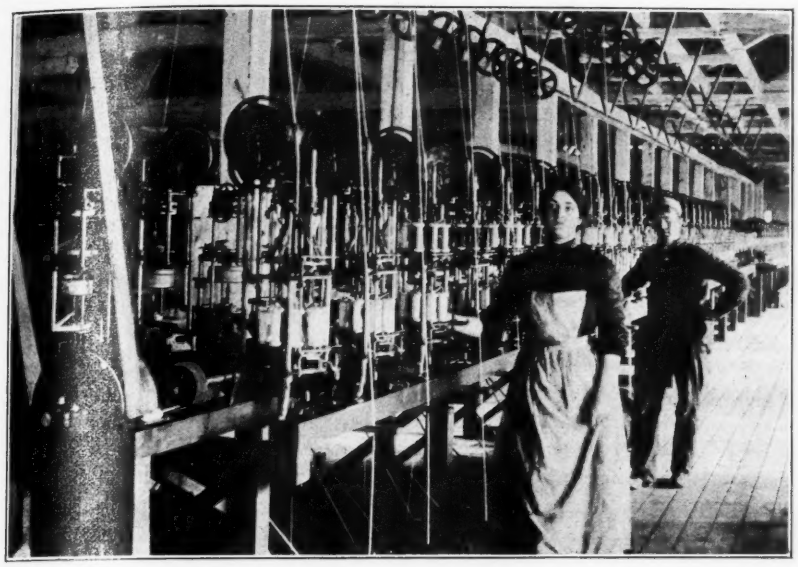
The Bickford Drill and Tool Company gives some interesting information as to progress in increased cutting speeds for drills. While two years ago the speed ranged from 9 to 188 revolutions and the feed ranged from 0.005″ to 0.007″, they are now enabled to drill a $\frac{3}{8}$″ (0 375″) hole at a feed of 1/6″ (0.06″) per revolution.

American Institute of Electrical Engineers.

At the meeting of the board of directors on November 21 the following names of associates were elected: Cooper Anderson, Grafton Wall Appler, William Warren Dean, John F. Easterbrook, Frank Malcolm Farmer, Clinton Jerome Hixson, Ray Herbert Manson, Sidney B. Martin, Frederick William Newell, Randolph Halliday Nexsen, Jay H. Perkins, Bert Ernest Semple, Frank Lord Sessions, Sidney Roby Sheldon, Arthur Harlan Stephens, Harry Stoddard Williston, Frederick Darlington.

A New Wire Factory.

Copper wire is an article of vast importance in our present industrial conditions and any news in connection with this is always interesting, particularly to the electrical trades.



Mechanical Braiding Machines.

It is difficult to realize the enormous amount of copper that is being consumed in this country, the most of it being used in electrical applications. In the year 1901 the total production of copper in the United States was nearly 270,000 long tons. The estimated amount of copper consumed for the same period was over 380,000,000 pounds.

By far the greater part of the copper used in electrical arts is in the form of wire, and the manufacture of this material is therefore a business of great importance.

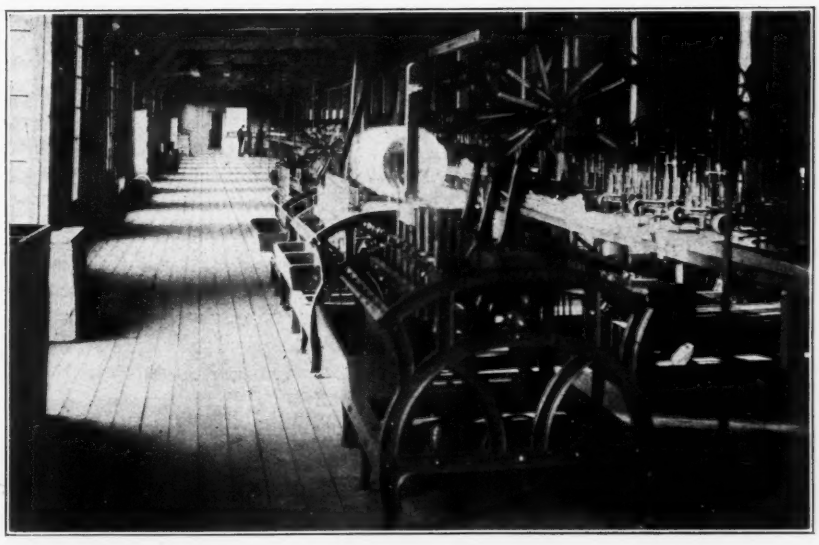
Copper wire is manufactured by drawing down from a rod to the desired size. For smaller sizes of wire, the rod is about three-eighths of an inch in diameter, and is reduced in size by being passed successively through dies, each of which reduces it several sizes. The wire may be passed through three or more dies in one operation. When this operation must be repeated a number of times to bring the wire down to the desired size, it is necessary to anneal it after each drawing. The effect of drawing the metal is to harden it, which would make it more difficult to draw through the next set of dies. The dies are merely metal plates with an opening of the proper size drilled into them. After the last drawings the wire may be left unannealed, and is then known as "hard drawn."

For electrical purposes, the wire must usually be insulated with some material. Various kinds of insulation are used, according to the purpose for which the wire is intended. For dynamo construction, the usual insulation is a double or triple layer of cotton wound on the wire by machinery. Annunciator wire is insulated by a double layer of cotton which is then saturated with paraffin to make it waterproof. Wire intended for outdoor use is covered with some material which will withstand the weather, and need not necessarily have a high insulating value. For interior wiring, the best grade of insulation is provided to reduce the risk of fire. This usually consists of rubber, of varying qualities, covered by a braiding of cotton for protection.

The rubber for insulating purposes is secured by the manufacturer in a crude state. This is comparatively pure, but contains more or less dirt which must first be removed. The process of cleaning consists in passing the crude material through mills which masticate it and wash out the dirt. It is then rolled into sheets about twenty feet long and hung up to dry. The drying process lasts from four to five weeks. After drying, the rubber is then compounded. This consists in adding to the pure material various substances, such as whiting, metallic oxides, rubber reclaimed from old shoes, etc. At this period from one to two per cent of flowers of sulphur is added for vulcanizing. No chemical reaction takes place at this time, and the sulphur is carried in the rubber as a mechanical mixture. After compounding, the material is passed through the mill and rolled out into sheets twenty-eight inches wide and from 200 to 300 yards long, of various thicknesses, depending upon the size of wire to be covered. These long sheets are rolled on reels, with muslin in between to prevent sticking. The rubber is still soft and plastic.

These long sheets of rubber are cut into tape of various widths and pressed around the wire to be insulated. In this process the tape is laid longitudinally around the wire and the edges pressed together by two inclined rolls, which make the joint and at the same time cut off the excess of material. When small wires are to be covered, a broad tape may be used, which is folded around two or three wires at a time, the whole being passed through two grooved rollers which cut the sheet apart, leaving each wire covered by a thin tube of rubber.

To protect the rubber, braiding is usually applied in one or two thicknesses. In



Mechanical Spinning Machines.

braiding, the wire is passed through a machine upon which two sets of bobbins are revolving in opposite directions and intermeshing with each other. After braiding, the wire, which is wound on reels, is placed in an oven and heated by steam to about 267 degrees Fahrenheit. This is the process of vulcanizing, and in it the sulphur reacts chemically with the soft rubber, forming a harder material.

Telephone cables are built up of wires covered with paper to reduce the capacity and spun into cables, which are taped and dried and then sheathed with lead.

Although the process, as described, seems simple enough, each step requires great care and skill to produce the best quality of wire. In this work experience is a prime requisite.

Recently, at Shousetown, Pa., in the neighborhood of Pittsburg, the American Cable and Wire Company has placed in operation a fine large wire factory, equipped with the most modern machinery. The main building is 135 feet broad by 250 feet long, and has two stories. Annexes provide accommodations for the power plant and waterworks. On the first floor is placed the rubber mill, which is directly driven by a Corliss engine. The rolls are sixty inches long and twenty-four inches in diameter, these being the largest rolls that have ever been used in working rubber. The colander is twenty inches in diameter and forty inches long.

On this floor are also the cable-making machine and machine shop, the oven and sheathing machine, as well as the general offices. On the second floor are braiders and insulating machines, the total equipment including 400 braiders and twenty-five machines for insulating annunciator wire and for office wire. The capacity of the factory, when fully equipped, will be 100,000 feet of rubber-covered wire per day, 50,000 feet of annunciator wire, 50,000 feet of office wire and from 5,000 to 10,000 feet of 100-pair telephone cable. The factory will employ 200 hands and will use about two tons of copper per day.

The officers are: David Carlin, president; Joseph A. West, vice-president; J. E. Powell, treasurer; H. W. Klein, secretary; M. W. Wachter, general superintendent.

The district office managers of the Westinghouse Electric and Manufacturing Company, representing all the principal cities of the United States, have spent a week recently in their usual annual visit to the works and offices of that company at East Pittsburg. On the evening of November 19 a very enjoyable dinner, in honor of the visitors, was given at the Duquesne Club, at which the engineers and executive officers of the company were also present.

THE PROBABLE FUTURE DEVELOPMENTS IN THE USE OF ELECTRICITY ON BOARD SHIPS.*

BY F. O. BLACKWELL.

The part played now by electric power in the design and operation of the latest steamships, especially men-of-war, is an important one, but it is my belief that the future promises for it an even more extended use.

There are three general subjects which I propose to discuss, namely:

The substitution of steam turbines for reciprocating engines for driving the electric generators.

The use of alternating-current generators and motors instead of continuous-current apparatus.

The operation of all auxiliary machinery on ships by electric motors.

These subjects are, of course, interconnected, but they do not necessarily have to be all considered together. For instance, continuous-current generators and motors may be used with steam turbines, and it may still be desirable to drive the auxiliaries by motors.

The steam turbine can not be regarded as a general substitute for the reciprocating engine, as its speed is too high for direct-connection to most machinery or for the safe use of gearing. For driving electric generators, however, it is ideal. Within reasonable limits, the higher the speed of electrical apparatus the smaller, lighter and more efficient it becomes.

Compared with the reciprocating engines and slow-speed generators now used in our navy, a turbine plant can be designed which will have but one-quarter the weight and take but one-tenth the space. It would also save weight in the structure of the ship on account of its lightness and freedom from vibration.

The steam turbine can be used with a high degree of superheat (when superheated steam comes into general marine use, as it undoubtedly will before long), because there are no lubricated surfaces in contact with the steam, and a high vacuum can be obtained because there are no piston-rod packings to leak air. The entire absence of lubricating oil in the condensed steam is also a great advantage to avoid deterioration and foaming in boilers.

The efficiency is very high, especially when we consider that it is the actual efficiency, including all mechanical and electrical losses, there being no such thing as indicated horse-power in a turbine.

The steam consumption of, let us say, a 300-kilowatt turbo-alternator at full load with dry steam at 200 pounds pressure and 28-inch vacuum would be about 20 pounds of steam per kilowatt-hour, or 15 pounds per electrical horse-power-hour. The steam consumption at one-half load would be about 22 pounds per kilowatt-hour. There is no objection, therefore, to putting in large units and running them much of the time underloaded.

In order to appreciate this it should be contrasted with the present reciprocating compound dynamo engines, which take 30 to 50 pounds of steam per kilowatt-hour at full load, and 40 to 65 pounds at one-half load. It is at least as efficient as the main engines at full power and, undoubtedly, much better than they are at cruising speed.

Of course it should not be forgotten that the average ship dynamo and engine now in use are of from 30 to 100 kilowatts capacity, and also that the high-speed alternator has a higher efficiency than the slow-speed, continuous-current generator, especially at low potentials when the commutator brush friction is high.

After describing the several alternating-current systems the question of periodicity was taken up. The speeds of most of the motors on shipboard are low, and sixty cycles would call for motors having large numbers of poles in most cases, which would mean large diameter and heavy weight. Twenty-five cycles is too low a periodicity for good lighting service, and does not give a high enough maximum speed for the turbo-alternators or the blowers and centrifugal pumps.

The choice lies between thirty and forty cycles, and my preference would be for forty cycles which gives a higher maximum speed and a rather better range of speeds. It is also the lowest periodicity that can be used for arc lighting which will probably be more used than it has in the past.

The various methods of distribution were then described, after which the author considered the auxiliaries. Driving all auxiliaries, including the feed, circulating and air pumps by motors, I believe to be more efficient and to have many advantages over steam operation.

It is argued because the exhaust from the auxiliaries is turned into the feed-water heaters and distilling apparatus, it makes no difference how much steam is consumed by them.

This is true to a certain extent, but the energy lost by leakage and radiation in the piping and cylinders can not be recovered. The hot steam pipes to the

*Abstract of a paper read at the tenth general meeting of the Society of Naval Architects and Marine Engineers held in New York, November 20 and 21, 1902.

auxiliaries are most objectionable in themselves, and a source of constant trouble in service. The auxiliaries are much less efficient when they are operated only occasionally or at less than their full capacity, when the ship is running at cruising speed or in port. The mechanical efficiency of the small engines is also very poor.

When the auxiliaries average 150 pounds of steam per indicated horse-power-hour, as they did on the U. S. S. Minneapolis, it means that one and one-half per cent of the heat energy of the steam is converted into mechanical power.

By using motor-driven auxiliaries, the oil which is introduced into the feed-water by reciprocating engines is also done away with and the resulting troubles with boilers avoided.

The combined mechanical and electrical losses in the generator, motor and electrical transmission can be less than twenty per cent.

With the steam economy in the turbo-alternator of fifteen pounds per horse-power-hour, this gives a steam consumption for the motor-driven auxiliary of eighteen pounds or about one-eighth that of the Minneapolis auxiliaries already referred to.

In order to have a basis of figuring I have assumed that the U. S. S. Connecticut and Louisiana will be equipped with steam turbines and alternating apparatus for driving all the auxiliaries. These battleships were authorized by the last Congress, and are being built at the Brooklyn Navy Yard and at Newport News. They are to have a trial displacement of 16,000 tons, a speed of eighteen knots, and main engines of 16,500 horse-power.

The specifications for the Connecticut and Louisiana now call for two separate power plants, each containing four 100-kilowatt generating sets. In order to take care of the other auxiliaries which the specifications did not contemplate operating by electric power a larger plant is required, and at the same time larger and fewer units can be used, which is permissible because of the high steam economy of the turbine on partial loads.

The total nominal capacity of all the auxiliary apparatus is 2,500 horse-power. Of this not more than 800 horse-power could possibly be in full operation at one time even when in action and going at full speed, and not more than 400 horse-power under ordinary cruising conditions or in port, not including the anchor windlass.

The electric power must be divided into two separate plants, each large enough to supply the maximum load of the entire ship. I would divide each plant into two units of 300 kilowatts each. The four steam turbines and generators would therefore each have a rated capacity of 400 horse-power with an overload capacity of 600 horse-power. The use of four units instead of eight will much simplify the electric installation.

The proposed four 300-kilowatt units would certainly not weigh more than one-half as much or take more than one-third the space of the eight 100-kilowatt engines and generators which are to be installed.

Assuming that the new standard generator potential of the navy (125 volts) will be used for lighting, and that the lamps will be connected between the neutral and one line, the potential between the three-phase lines will be 220 volts. This gives a single-phase, low-potential wiring system without introducing any complications and a higher pressure power system. By grounding the neutral, the strain on the insulation might be limited to 125 volts, but I hardly think this necessary, as 220 volts is not a high enough potential to cause any trouble.

I believe the lighting regulation of a large marine power plant of this character, notwithstanding the much greater motor load proposed, can, by means of the automatic devices now perfected, be kept much more constant than in existing continuous-current marine practice and permit the use of three watts per candle-power lamps instead of the low-efficiency, four-watt lamps now generally employed. This would mean a saving of twenty-five per cent in the cost of power for lighting.

The present system of turret turning, in which the speed of the motor is regulated by varying the field strength of a continuous-current generator, gives such perfect control over the training of guns that it can hardly be improved upon; but I would suggest that the same method of control be adopted for elevating and depressing the guns. By keeping the gun constantly aimed at the target, regardless of the motion of the ship, it could be fired the moment the breech was closed and the rapidity and accuracy of fire greatly increased.

The long line of piping required to operate the steering gear by steam is most objectionable, as it heats up the ship and cuts through the water-tight compartments. It is also inefficient on account of the constant condensation in the pipes, which must be large enough to carry the maximum load, although the average load is very low.

This is another case where continuous current has decided advantages. The steering engine is constantly starting and stopping, and will take 100 horse-power at times, so that any method of control which requires the making and breaking of heavy currents is objectionable.

A modification of the variable potential control used for the turrets, in which only a small field current passes into the controller, would be best for electric steering.

Hoisting with induction motors presents no difficulties. The continuously running hoists would be driven by constant speed motors. The cable hoists would have variable speed motors, permitting the hoist to be started gradually and run below synchronous speed.

The speeds of blowers could be much increased over those now used, especially with alternating motors. Higher efficiencies and much reduced weights of both motors and blowers could be obtained by increasing the revolutions and reducing the diameters.

In conclusion, I would say that I think the steam turbine is the coming method of driving generators.

Its rotary motion, light weight, small size and high efficiency at all loads make it particularly suitable for marine use.

Alternators are best adapted to be driven by high-speed turbines, but alternating current has both its merits and demerits. For transmitting power polyphase current is most economical, and the induction motor for constant speed can not be equaled for simplicity of construction and ability to stand hard usage. It does not, however, permit of as economical or exact speed regulation as a continuous-current motor, although there are possibilities of the development of an alternating commutating motor which will meet these requirements.

As the majority of motors on shipboard run intermittently at variable speed, the selection between continuous and alternating current should only be made after thorough investigation.

As to the more extended use of electricity for all purposes I have no doubts. It permits the concentration of the generation of power in one place and its easy distribution over any distance and its divisibility into small or large amounts.

The electric motor is efficient, reliable and clean. Its convenience and the ease with which it can be controlled make it suitable for every kind of service. Its universal adoption on shipboard will increase the economy of the ship, either making the coal supply more effective or giving increased weight applicable to guns or armor. But more important still, it will permit quicker and more accurate work with each piece of mechanism, and, therefore, adds to the efficiency of every man in the ship's crew.

The Western Ohio Railway.

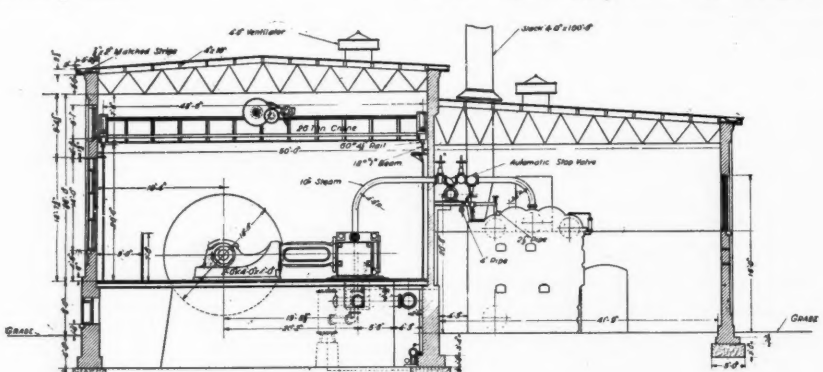
Engineering Features of a High-Speed Electric Road.

By D. W. Pell, Superintendent of Construction.

THE Western Ohio Railway Company operates at the present time forty-seven miles of road and has under construction sixty-four and one-half miles more. The portion of the line now in operation begins at Lima, in Allen County, Ohio, runs south from Lima to Cridersville and Wapakoneta, west to St. Mary's, south from St. Mary's to New Bremen and Minster, and finally west from St. Mary's to Celina.

POWER-HOUSE.

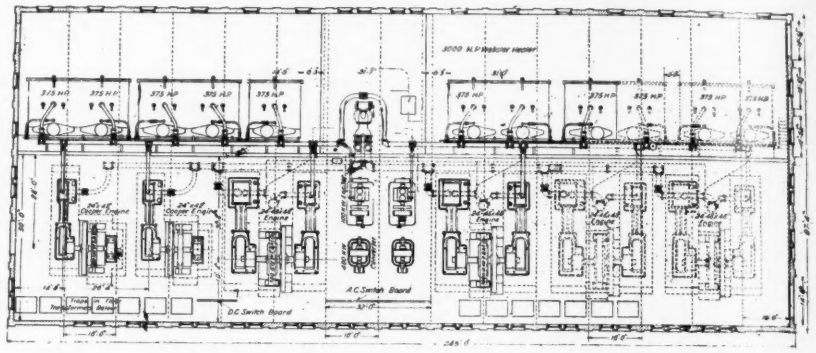
The main power-house is located at St. Mary's. The building is of brick and concrete, no building stone whatever being used in its construction. The general dimensions are as follows: Extreme width 104 feet, extreme length 248 feet, width of boiler room 45 feet and width of engine room 52 feet. The floor level of the boiler room is 12 feet lower than that of the engine room, and under the latter there is a 12-foot basement. This basement will be used, when the plant is completed, as a stationary transformer room. The engine room floor consists of steel "I"-beams with brick arches filled in between with concrete. The roof over the entire building consists of flat steel trusses carrying three-inch tile, with a four-ply asphalt and gravel covering. The engine room is supplied with a twenty-five-ton Chisholm & Moore, hand-power traveling crane.



TRANSVERSE SECTION OF POWER STATION, WESTERN OHIO RAILWAY, ST. MARY'S, OHIO.

The maximum capacity of this station, according to the present plans, will be 4,000 kilowatts. Just now, however, only two 400-kilowatt machines are installed, and foundations have been completed for two 750-kilowatt generators, which will be erected and placed in operation this coming fall. The engines are of the C. & G. Cooper, horizontal, cross-compound, condensing type with Corliss valve gear, and were designed for parallel operation on alternating-current, three-phase work, with a guaranteed regulation of one per cent.

The boiler equipment consists of eight Stirling boilers of a total capacity of 6,000 horse-power. These boilers are equipped with flat grates and are each supplied with independent-guyed steel stacks, each stack being forty-eight inches in diameter and eighty feet high. The boilers are all hand fired, coal being supplied directly in front of the fire doors by a Hunt industrial railway system, consisting of a narrow-gauge track with turn-outs, track, scales and steel cars, each having a net capacity of one ton. The coal is shoveled directly from these small cars into the boiler furnaces. The grate bars are all of the well-known herring-bone type, with half-inch opening. The fuel burned is West Virginia semi-bituminous "run-of-mine," which has been found to be the most economical for this particular plant.



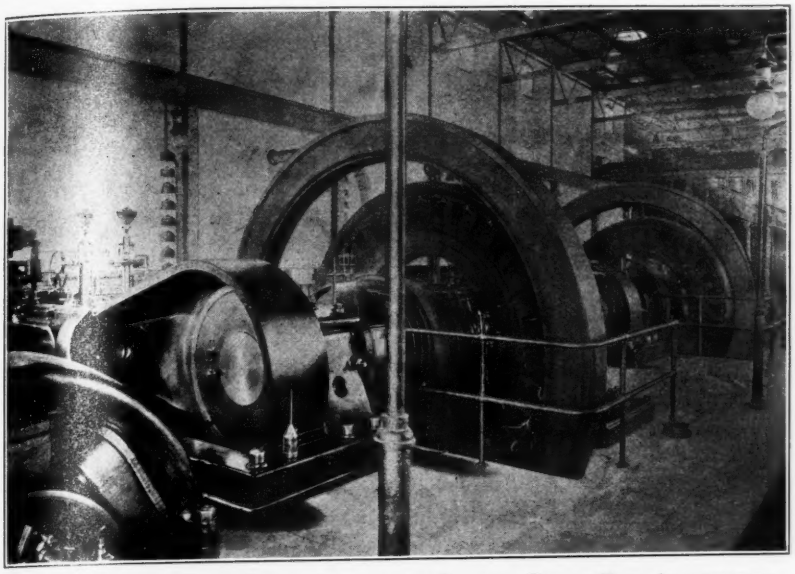
PLAN OF POWER STATION OF WESTERN OHIO RAILWAY, ST. MARY'S, OHIO.

The pump and condenser room in this plant is located in the centre of the main boiler room and contains all of the feed pumps, feed-water heaters, circulating pumps, vacuum pumps and condensers for the entire plant. The water supply is taken from the feeder of the St. Mary's reservoir, and is brought about 3,800 feet through a twenty-four-inch pipe. The thirty-inch Worthington elevated injector condenser includes an eight by sixteen by twelve-inch rotative, dry, vacuum pump and two Worthington circulating pumps, either of which will be of sufficient capacity to operate the entire plant. The main steam header consists of sixteen-inch heavy, lap-welded, steel pipe made up in sections with pressed steel flanges shrunk on and then turned and faced. The feed and blow-off pipes, including fittings, are all of extra Crane patterns, as are all valves. Valves over eight inches in diameter are by-passed. All valves and fittings over three inches in diameter are flanged, the flanges being tongued and grooved. The main steam-header is carried on a specially designed, cast-iron roller frame, one end resting on the rear of the upper walls of the boiler setting, and the other being built into the brick-work of the division wall between the boiler and engine rooms. The feed-piping is suspended from the roof trusses by long "I"-bars having turn-buckles in them to allow for adjustment and variations of height. All feed valves are arranged to be controlled from the boiler-floor line, as are, also, all drips, gauge-cocks, water gauges, water columns, blow-off pipes and drains around the boilers.

GENERATORS.

The electrical apparatus is furnished by the Westinghouse Electric and Manufacturing Company. The main generating units are direct-connected to their

several engines, and each of the two units now in operation is of 400-kilowatt capacity. The machines are of the revolving-armature type, and since they run at 100 revolutions per minute and have thirty poles, they deliver current at 3,000



Two 400-Kilowatt Three-Phase Alternating-Current Engine-Type Alternators, 400 Volts, 100 Revolutions per Minute.

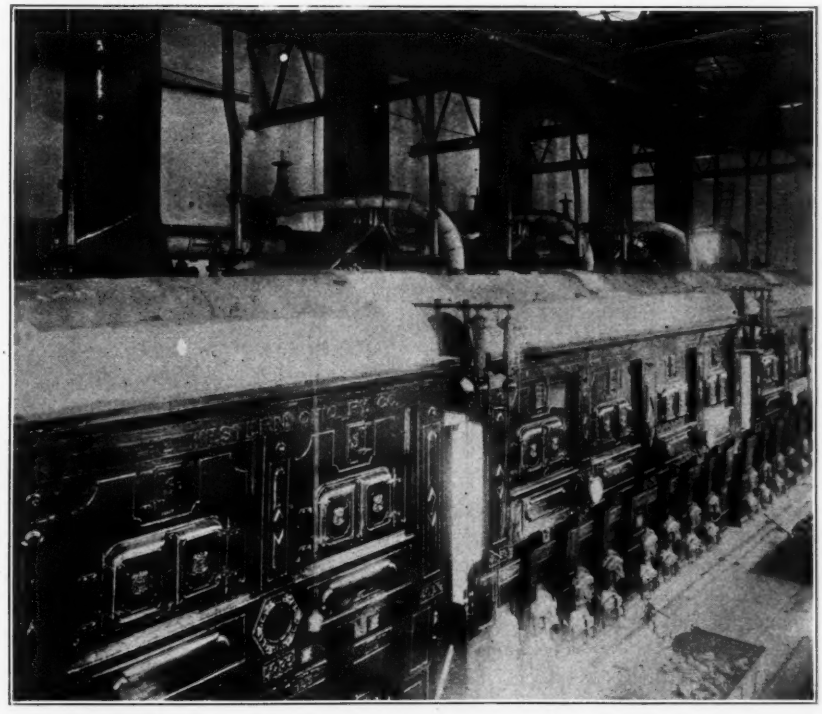
alternations. The armatures have three-phase windings for a normal output of 400 kilowatts and are guaranteed to deliver 577 amperes each per terminal at 400 volts, with a non-inductive load. These generators are separately excited and require for excitation when the armature is delivering its full-rated current, ninety amperes at 100 volts. The 750-kilowatt generators are designed for a speed of ninety-four revolutions per minute, being thirty-two-pole machines of the revolving field type. The normal output of these machines at 750 kilowatts will be 1,083 amperes per terminal at 400 volts, three-phase, with a non-inductive load, and at this load they will require 150 amperes at 100 volts for excitation purposes. Throughout the armature spider, core and winding, large ventilating ducts have been provided which permit a free circulation of air during operation. For exciting the main generators, there will be two units, both steam driven and of the Westinghouse type, the generators of 100-kilowatt capacity and operating at 125 volts and 200 revolutions per minute, being direct-connected to two thirteen by twenty-two by thirteen-inch Westinghouse compound engines.

The main power-house contains, also, a substation—that is, a portion of the low-potential current from the main generators is carried to two 400-kilowatt rotary converters supplying approximately twenty-five miles of the feeder system of the line. The rotary converters in the other substations are all of the Westinghouse type and of 200-kilowatt capacity. The armature winding of the rotary converters is similar to that of ordinary direct-current generators, but it is tapped at certain points from which leads are carried to collector rings at one end of the staff, while the ordinary direct-current commutator is at the other end. The ratio of conversion, alternating current to direct current, is about 0.62. These rotary converters operate at a speed of 500 revolutions per minute, and deliver 333 amperes at 600 volts. For starting a small induction motor is permanently mounted on the same shaft with the armature.

SWITCHBOARDS.

The engine room at the power-house will contain two switchboards, a main generating board containing eleven panels and an alternating-current board of nine panels, upon which will be mounted the high-tension switches for all outgoing transmission lines. These switchboards are all of blue Vermont marble, and are equipped with the bus-bars and cables necessary for the proper handling of the apparatus in the station. All instruments on the boards are of the Westinghouse, long-scale, dead-beat type.

The step-up stationary transformers, which are located in the basement, are of the oil-cooled type. There will be seven of 400-kilowatt capacity, transf rming the current from 390 to 33,000 volts. From the transformers, lead-covered, single-conductor cables will be led up the south wall of the building to the high-potential circuit-breakers, of which there will be nine of the Westinghouse type mounted on a wooden framework.



Partial View of Boiler Room, Power-House, St. Mary's, Ohio.

SUBSTATIONS.

The substations along the route will be seven in number and will be located as follows: Rawson, Beaver Dam, Lima,

Wapakoneta, Anna, Sidney and Lockington. The substation buildings will be of the general construction shown by the accompanying drawing. They will be of brick, with thirteen-inch walls above the foundation line, the coping being covered with cement. The floors in all substations are to be of concrete, as are also the transformer pits.

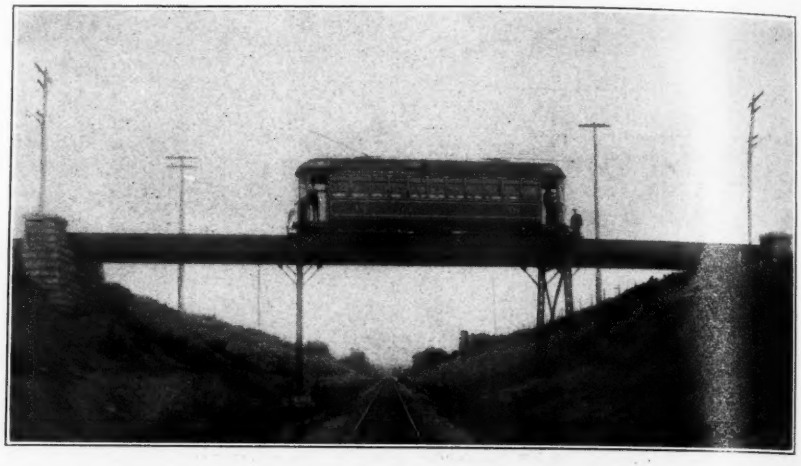
In addition to the substations mentioned, there will be a portable substation mounted on a car. This car will be twenty-seven feet long, eight feet ten inches wide and ten feet six inches high from the top of the rail. The equipment includes one 200-kilowatt rotary converter; three 150-kilowatt step-down transformers; three "low equivalent" lightning arresters; three fuse-switch circuit-breakers with barriers, and one three-panel switchboard, including an alternating-current, rotary converter panel, direct-current, rotary converter panel and direct-current feeder panel.

TRANSMISSION LINES.

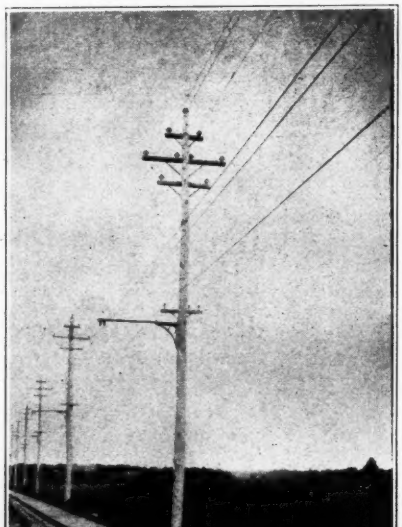
The high-tension line from Wapakoneta to St. Mary's is carried on forty-five-foot poles, the top of the poles being arranged for three sets of 33,000-volt lines. At Wapakoneta one set turns off south and supplies the substations at Anna, Sidney and Lockington. The other two sets continue north as far as Lima, one set supplying Wapakoneta and Lima and the second set supplying Beaver Dam and Rawson. The transmission cables themselves are all carried on steel pins with wooden tops and Locke No. 507 porcelain insulators. The cross-arms are of long-leaf yellow pine, fastened to the pole with two one-half by thirteen-inch carriage bolts. All the high-tension lines are completely spiralled every mile, each set being spiralled on a direction opposite to the adjoining one, thus keeping the same phase feeders on the two pins next to the pole on each side.

CARS.

The first eight cars on this road were built by the G. C. Kuhlman Company, of Cleveland, and comprise five passenger coaches and three combination passenger and express coaches. The cars are forty-two feet six inches over all and eight feet eight and one-half inches wide. The car bodies are mounted on Peckham No. 14AX trucks, with spoke-wheels thirty-three inches in diameter, two and three-quarter-inch tread, with one by one-inch flange. The electrical equipment consists of four Westinghouse No. 56 railway motors with K14 controllers. All cars are double-ended and are geared up to a maximum speed of forty-eight miles per hour with a gear ratio thirty to fifty-two. All axles are five inches in diameter and the motors are mounted on the trucks with nose suspension. Straight air-brakes are used and each car is supplied with an independent motor-driven compressor mounted on a dust-proof box on the under side of the car. The Niles Car and Manufacturing Company, Niles, Ohio, now has an order from the Western Ohio Railway Company comprising twenty-four passenger coaches, each forty-four feet ten inches long over all and eight feet nine inches wide. These coaches will have standard "I"-beam framing for the floor sills and will be equipped and mounted on the same trucks and with the same equipments as those furnished by the Kuhlman Company.



OVERHEAD CROSSING, WESTERN OHIO RAILWAY, OVER TRACK OF CHICAGO & ERIE RAILROAD.



FORTY-FIVE-FOOT POLE LINE CARRYING BOTH TROLLEY AND TRANSMISSION CIRCUITS.

ROAD-BED.

The road-bed on the first forty-seven miles of this property is of standard interurban railway construction, consisting of sixty-pound steel rails thirty feet in length laid on five by seven by seven-inch ties. The bonds are of the American Steel and Wire Company's "Crown" type. The road-bed is heavily ballasted throughout with rock crushed to one and one-half-inch ring gauge and screened, and is from eight to twelve inches in thickness under the ties. This ballast is carried out six inches beyond the ends of the ties and carefully shouldered and sloped to provide ample drainage for the road-bed proper. The entire line is built upon private right of way. The maximum grade on the line now operating will not exceed two per cent, except at points where the line crosses over the main lines of steam roads. The road-bed on the balance of the property, which is now being constructed, will be of very heavy construction, consisting of ties six by eight by eight inches, placed two feet on centres, and laid with seventy-pound "T"-rails in thirty-foot lengths. The bonds are to be the American Steel and Wire Company's solid terminal type, which are to be placed by an hydraulic compressor. The grades on extensions, as well as on curves, are to be carefully looked after and eliminated wherever and whenever it is possible to do so, making the route practically an air line.

OVERHEAD CONSTRUCTION.

The poles on this line are all of Michigan cedar, thirty-five and forty-five-foot lengths, with seven-inch tops. All cross-arms have been deeply gained in the pole and fastened by machine and carriage bolts instead of the customary lag screws.

The brackets used are of the rigid type, with Ohio Brass Company's hangers. All cars are of the twelve-inch semi-cylinder type, soldered in position. The poles are all thoroughly guyed and braced on all curves, and it has been the aim to make the overhead line substantial in order to stand the high speed of heavy railway cars. The trolley wires are of the round type, there being two in number, of 00 capacity each. Above the trolley is strung a 211,000-circular-mil feeder, carried on a cross-arm twelve inches above the trolley bracket. On these same cross-arms, over the entire route, are carried the telephone lines, there being an iron box telephone in a wooden booth at each

PNEUMATIC SIGNAL COMPANY'S HALF INTERLOCKERS.—CELINA DIVISION.

turnout, where all cars must report. This telephone system is carried into the general offices of the company at Lima, where the despatcher is located, so that he is constantly in communication with all of the cars on the system, as well as the power-house and substations.

The portion of the road now in operation traverses the Lima-St. Mary's oil fields, which are among the heaviest oil-producing districts in the country. It also traverses a rich farming territory and the prospects for freight on this road are very bright. The rate of fare charged is approximately two cents per mile and the run from Lima to Minster, a distance of 36.8 miles, is being made in one hour and forty-six minutes, including all stops.

New York Electrical Society.

At the 228th meeting of the New York Electrical Society, held Tuesday evening, November 25, the following members were elected: W. A. Belden, Thompson D. Harbinson, J. O. Sinkinson, M. B. Foster, Leon E. Schmielsew, W. C. Andrews, Charles R. Pratt, Harold Melbin, E. B. Conrad and A. Frederick Collins.

ARE FISHES KILLED BY LIGHTNING?

BY DR. JOHN TROWBRIDGE.

In a late interview with a reporter I remarked upon the difficulty I had in making sparks of great length strike the level surface of water, and I expressed the belief that lightning rarely strikes the level surface of the sea. Indeed, this reluctance of electric sparks to striking from a point or an extended surface to a plane has long been known. When clouds are very low lightning may strike the sea.

I have received many letters from observers who are positive that they have seen lightning strike the sea or large bodies of water; moreover they bring forward the evidence that fishes were seen to float with their bellies upward, having been killed by the lightning shock. However it may be in regard to the accuracy of the observation of the point of striking of the lightning, I think that the evidence of the death of the fishes does not bear upon the question of lightning striking the sea. It is well known that fishes are killed by the concussion due to the explosion of charges of dynamite and to the reports of cannon. The explosion accompanying the manifestation of lightning is probably the cause of the death of the fishes and not the electrical shock. One can calculate that the difference of potential between the back and the belly of a fish in a large body of water, like a lake or a sea, taking into account the extremely small resistance of a great sectional area of water between which the fish swims, must be too small to shock the fish.

Cambridge, Mass., November 19.

Electrometallurgical Problems.

In a series of papers in the London *Electrical Review*, Mr. A. A. Beadle discusses methods of producing and refining gold and silver. Gold occurs almost exclusively as native metal and the ores may be divided into several classes. Those known as free milling which, when finely crushed, give up the bulk of the gold when passed over amalgamated plates. The refractory ores will not yield to the above treatment and must be treated by cyaniding or chlorination. The only known mineral form of gold is the telluride, the compound of gold and tellurium. The only application of electricity to the free milling ore is that due to Malloy, which was intended to prevent the sickening or oxidizing of the amalgam. Mercury was used as a cathode in dilute sodium sulphate, and the small deposit of sodium made by the current is sufficient to keep the surface bright. Many methods have been devised for electrolyzing ore directly, but none has been successful. The most satisfactory methods are those in which the ore is treated with a very dilute solution of potassium cyanide, which has the property of dissolving out the metallic gold. The solution must be extremely weak and time allowed to extract the metal. After the metal is secured in solution, there are several methods of depositing this. Siemens & Halske use iron anodes and lead cathodes, cupelling the latter after a sufficient deposit of gold has been obtained. Andreoli oxidizes the lead plates so that the gold deposit strips off the sheets. Cowper-Coles used aluminum cathodes. The gold may be deposited while passing the solution over zinc shavings, but this is satisfactory only when the cyanide is comparatively strong. Telluride ores are difficult to treat. If they are roasted, some of the gold is volatilized, and they are soluble only with difficulty in potassium cyanide. There are but few electrical processes for extracting silver from the ore, although it would seem that electrical precipitation might offer several advantages, principally on account of the purity of the deposit. The author describes briefly some of the metallurgical processes in use for reducing silver ores, and then passes to a description of the Moebius process of refining silver. In this process, silver is deposited from a solution of its nitrate by a heavy current, and comes down in the form of loose crystals, which are brushed off the cathode and caught on muslin trays. The process is very satisfactory and is widely used. Fused electrolysis is in no way applicable to the winning of silver from the average silver ore.

Reviews of Current Engineering and Scientific Literature.

Giving Concisely the Substance of Important Papers in the Scientific, Electrical and Engineering Press of the World.

Magnetic Resistance of a Stretched Bar.

The behavior of an iron bar when magnetized and subjected to a tensile stress has been studied by M. Fraichet. The bar was surrounded by two coils, one of which carried the magnetizing current and the other served as a test coil, being connected to a galvanometer. When the bar is stretched some of the fibres will give way sooner than others, so that they break one at a time. Whenever a fibre breaks the galvanometer is deflected, showing a change in the flux. The extent of the swing of the galvanometer indicates the size of the fibre which gave way. Immediately after the break, non-fibrous iron flows into the crevice, closing this up and allowing the flux to regain somewhat its normal value. The more fibrous the metal, the more marked its behavior. It is not noticed when a bar of hard-tempered steel is tested, as this has no fibre. Here the flux changes gradually until fracture takes place. This is also true of any bar that has been stretched beyond the elastic limit. The elastic limit may be defined either as the limit for the fibrous or the non-fibrous material. The two limits usually lie close together and are near the mechanical limit found from the testing machine, though some qualities of iron, such as puddled iron, show deflections of the galvanometer as soon as the stress is applied. —*Comptes Rendus* (Paris), October 27.

New Smelting Plant at El Paso, Tex.

This is a description, by Mr. C. W. Arthur, of one of the largest and best equipped smelters in the world. It has been built to replace the old plant, which was totally destroyed by fire about a year ago. The plant, although enormous in capacity, is very compactly built, occupying not more than nine acres. The capacity at present is 40,000 tons of ore per month. Electrical apparatus and methods have been adopted wherever possible. The machine and forge shops are briefly described. To the west of these is the power-house, which furnishes the motive power for almost everything about the plant and the neighboring town. This is a large building with a steel roof and an iron floor, and contains four large Corliss engines of the cross-compound condensing type, aggregating 2,000 horse-power. Here there are two generators of 500 kilowatts, two of seventy-five horse-power each, and one for 2,000 lights. Nearly all of the machinery is directly connected to motors. The pumping plant is very complete. All the pumps are in duplicate and are operated by motors. There are nine furnaces at the mill, seven for lead and two for copper. All of the material used in charging is carried to the top of the furnace by electric trolley cars of eight tons' capacity. The third-rail system is used for operating these. These cars pass beneath the freight cars containing the material or under the storage bins. They are then passed to a hydraulic elevator, and, after being raised to the top of the furnace, are run over an electric road to any designated hopper. The sampling mill is fitted with small roller mills, operated electrically. The pumping plant is situated at some distance from the mill, and the water is stored in elevated tanks and five reservoirs.—*Mining and Scientific Press* (San Francisco), November 15.

The Electric Installation of the Hydro-electric Company of Fure and Morge.

This company has erected a generating plant thirteen kilometres from Grenoble, at the junction of the Drac and Romanche rivers, and from here distributes the power generated to numerous substations along the valley to Fure and Morge. The River Drac which feeds the turbines is exceedingly capricious. The flow of water varies greatly, and has been as low as 30 cubic metres per second and as high as 700 cubic metres per second. The intake canals and waterworks are very complete and handle this extreme variation without difficulty. The water is carried to the power-house in a pipe 3.3 metres in diameter and 4,600 metres long, 2,100 metres of which are concrete, the remaining part being of soft steel. As the mass of water moving in this is very great, it was necessary to prevent shocks which would arise when the flow was changed at the station. With this object in view, three stand-pipes have been erected at different points of the pipe, the smaller of these being made of concrete, 9 and 20 metres high, respectively. The third stand-pipe is placed near the station and is built up of boiler plates, and is 35 metres high and 3.3 metres inside diameter at the base, tapering to 1.4 metres at the summit. This is placed at the far end of the forebay. Within the station there are five generators coupled directly to the turbines. These have a speed of 300 turns per minute and give 3,000 volts at fifty cycles, three-phase. Each group has a capacity of 1,350 horse-power. There are, in addition, two small turbine sets driving 150-horse-power exciters. The pressure, before leaving the station, is raised by means of transformers to 26,000 volts. There is one transformer for each generator. These transformers are of the three-phase type, having three cores. The switchboard is divided into three parts. The first contains all the measuring instruments, and is placed on a balcony overlooking the dynamo room. The second section of the switchboard contains the switches and interrupters, both for the transformers and generators. This is placed directly beneath the balcony. The third section is mounted behind the first board, and contains the switches and interrupters for the high-tension circuits and, in general, all the apparatus for this high pressure. The high-tension lines leave the station through glass tubes inserted in the wall. They are then carried on metal poles by means of glass insulators. The poles are about fourteen metres high and will carry, ultimately, twenty wires. The wires are arranged so that there is a distance of twenty centimetres between any two of one circuit. The poles are placed sixty metres apart. At the substations a substantial house is provided for the transformers. Here the pressure is reduced to 2,000 or 1,000 volts for local distribution. In some cases the pressure is reduced directly from 20,000 volts to 120 volts. The output of the station is used principally in factories. The price varies from 150 francs per horse-power-year of twenty-four hours per day to 125 francs per horse-power-year for twelve-hour daily service. This is considerably less than the cost of steam power in that locality.—*L'Industrie Electrique* (Paris), November 10.

An Indicating and Registering Wattmeter.

This is a description, by M. A. Bainville, of a new type of wattmeter brought

out by the Olivetti Company, of Ivrea, Italy. A feature of this instrument consists in the method of recording the readings. This is effected by a small motor which is started or stopped or run in the opposite direction, according as the power to be measured rises, remains constant or decreases. The instrument contains a pair of series coils, within which is placed a small pair of pressure coils. The latter can move slightly on a spindle. Attached to this spindle is an arm which opens or closes the circuits, depending upon its position. To the other end of this arm a yoke is attached to a spiral spring. When the power transmitted through the wattmeter changes, the small movable coils are deflected. This makes a contact with one of the circuits just mentioned, and in this way starts a small motor, which, through a worm gear, coils or uncoils the spiral spring mentioned above, and at the same time shifts the recording pen. The motor continues to run until the tension on the spring is sufficient to bring the movable coils back into a position where the motor circuit is opened. At this instant the motor ceases to run and the position of the pen remains fixed until a further change of power causes it to be shifted. The recording pen traces a record on paper moved by suitable drums and clockwork. A scale and pointer serve to make the instrument direct-reading, as well as recording. By replacing the series coil with a second pair of potential coils, the instrument is converted into a voltmeter. As the shifting of the recording pen is effected by a motor, no work is done by the moving coils, so that the sensibility of the instrument can be very great. The article shows a number of types of motor, with details of their construction.—*L'Electricien* (Paris), November 8.

A Supplement to Lieutenant Solari's Report on "the Radio-Telegraphic Expedition of H. I. M. S. Carlo Alberto."

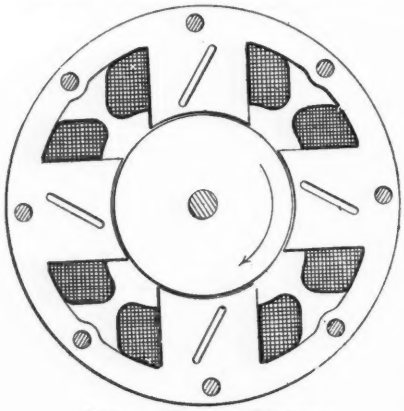
In this article Mr. Nevil Maskelyne gives an account of the effect of the messages sent out from Poldhu on his station. This station was located at Portheurnow, Cornwall, for the purpose of signaling to vessels now being fitted for wireless installations, and the author personally superintended the erection of this station and, last August, pending the erection of the mast, set up a scaffold pole carrying a diminutive collecting circuit in order to make preliminary tests and adjustments. At once he began to receive signals and messages in the Morse code. These signals did not continue all day, but at certain regular times. At each quarter of an hour they began, and continued for about ten minutes. There was a definite plan of working, the signals commencing with a certain call. This was followed by about 200 repetitions of the letter S, next a small item of news, and finally a signature. Copies of the original slips are reproduced in this article. As Poldhu was about eighteen miles away, the supposition was that these signals came from that point, and the call and signature lent weight to this opinion. As the apparatus installed in this station was not fitted with Marconi's syntonic apparatus, the supposition was that no attempt at syntony was being made at the Poldhu station. A question was raised why this was not done. After erecting the mast and a full-sized collecting circuit, the problem presented was not how to intercept messages from Poldhu, but how to deal with their enormous excess of energy. This was done by relaying the receiving instrument through land lines to the station in the valley below, and all of the Poldhu signals were sent to his house throughout the night and day. At one time, when the receiving instruments were behaving in a most peculiar manner, examination showed that two messages were being sent simultaneously, and a careful study of the record revealed the fact that this was due to the superimposing of a series of dots upon a regular message. By a suitable choice of capacity and inductance the two sets of signals were separated, and are reproduced in this article. The inference drawn from this is that the signal is intended to prevent any station nearer than the vessel intercepting the message. It is stated that a number of signals which were received by the Carlo Alberto so successfully were repeated again and again before the vessel succeeded in recording them. It is further stated that the records at the Portheurnow station show that the speed of transmission was about five words per minute. It is held that a station such as that now operating at Poldhu will upset every other station on land and sea within a radius of 100 miles, and in this way interfere with the chief utility of wireless telegraphy—that of signaling between ship and shore.—*Electrician* (London), November 7.

Special-Shaped Magnetic Poles and the Way They Affect Commutation.

"It is not a difficult question," says Mr. F. W. Davies, "to design a machine that shall be to all intents and purposes perfect as regards its commutation." The difficulty is that a machine designed with this idea in view may be an expensive one to manufacture. It is necessary not only to make a machine good, but to make it cheap. By suitably proportioning the parts of the machine, it is possible to combine sparkless running with a not excessive cost of manufacture; but designers have not been satisfied with this, and have brought forward various devices for improving the commutation. A number of these refer to the shape of the magnet pole-pieces. In order to design a sparkless machine, the initial magnetic induction in the air-gap under the polar horns should be as high as possible, so as to afford a good reversing field, and the cross-magnetization of the magnet pole-pieces brought about by the reaction of the armature should be minimized. Further, the field in which the armature revolves must be magnetically rigid, and the permissible sparkless movement of the brushes should be fairly large. A high magnetic induction in the air-gap may be obtained by making them as small in area as possible. If the polar arc be reduced indefinitely, the brushes will require to be moved through an abnormally large angle with variations in the load, and if the armature be toothed, the induction in the teeth will be too high. The experience has shown that it is best to make the polar angle about 140 degrees for a two-pole machine, 68 degrees for a four-pole machine and 44 degrees for a six-pole machine. Cross-magnetization may be prevented by increasing the reluctance of the path taken by the cross-magnetizing flux. This may be done by sealing the pole-pieces or by making these of cast iron. The field may be stiffened by increasing the length of the gap under the pole-tips, which can be done by boring out the poles non-concentric with the armature, or by planing off the tips. The same result may be accomplished by bridging the pole-tips with a fine web of metal, as this affords a path of no reluctance. The web and the adjoining portions of the pole-pieces are saturated, and, as a result, the field is not easily distorted. The field may also be stiffened by giving the pole a projecting tip. A strong field is always desirable, yet if the commutating field be too strong the neutral line on the commutator will be sharply defined and there will be difficulty in securing sparkless commutation. The author does not state whether he thinks it advisable to design a machine on ordinary lines or to resort to any of these special devices.—*Electrical Review* (London), November 14.

Electrical Patents

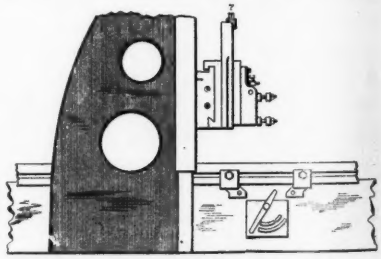
Mr. Alexander Churchward, of Chicago, Ill., has patented a dynamo-electric machine, the object of which is to provide simple means for overcoming the injurious effects of armature reactions. Mr. Churchward describes his improvement as follows: "My invention is designed more particularly for use in connection with the direct-current dynamo-electric machines, as the induction in alternators is not usually of so high a value, the disturbing influences being more effective in direct-current machines. The rotation



DYNAMO-ELECTRIC MACHINE.

of an armature in a field of lines of force is usually accompanied by the displacement of the lines of force and the distortion of the uniformity of induction. I provide an improved means for eliminating these defects and to increase the inherent tendency of the machine to regulate itself automatically. In order to deflect the lines of force more closely toward the entering pole-tips and to prevent the same from congregating at the leading pole-tip, I provide a slot in each polar projection which preferably extends diagonally with relation to the polar axis. Where the armature is adapted to run in either direction, I preferably provide two diagonal slots in each polar projection, one slot in each pole acting in the above-mentioned capacity when the armature is running in one direction, while the remaining slot acts in the same capacity when the direction of rotation of the armature is reversed. In practising my invention I also preferably chamfer a portion of each of the pole-tips in order to distribute the flux which tends to concentrate at the entering pole-tips, the lines of force then emanating from a larger pole area and being more evenly distributed over the armature surface by which means the plane of commutation is displaced but slightly, and while it may not coincide with the neutral plane, it may be so chosen that the conductors of the armature which are under commutation will then more readily permit of the reversal of current therethrough at any load. Where the machine is designed to rotate in both directions, it is obvious that what at one time may be the trailing pole-tips are at another the entering pole-tips. I therefore chamfer, preferably, about one-half of each pole-tip, by which arrangement I am enabled to reduce the injurious effects of armature reactions and at the same time do not impair the effectiveness of the entering pole-tips, as a portion of each entering pole-tip remains intact, being thereby brought within effective range of the armature."

The Niles Tool Works Company, Hamilton, Ohio, controls a patent recently issued on a novel tool relief for metal planers, which is the invention of Mr. Adolph L. De Leeuw, also of Hamilton, Ohio. The planer is of the same general nature as that now ordinarily well known, having a bed, a table, suitable rails, saddle, swivel, slide, tool box and tool clamps, also the usual apron. A pair of electromagnet spools are, however, mounted on the front face of the upper portion of the tool box above the hinge of the apron, the axes of the spools being parallel and projecting forwardly from the tool box in a common horizontal plane parallel with the axis of the hinge pivot of the apron. An armature is disposed across in front of the cores of the electromagnet and stands normally some little distance forward of the magnet poles. From the apron a lever arm projects rigidly upward to the rear of the armature and between the magnet spools, while a pair of studs project rigidly forward from the face of the tool box above the magnet spools. Hangers are also provided, which project upwardly from the armature and have their upper ends pivoted to the forward ends of the studs, whereby the armature is pivotally suspended. A set screw extends through the central portion of the armature, its inner end being adapted to impinge against the forward face of the upwardly projecting lever arm. A switch lever is mounted on the planer bed and a pin is carried by a dog that is adjustable along the planer bed and is adapted to strike and shift the switch lever as the table nears the completion of its cutting stroke. Another dog pin is arranged to shift the switch lever again as the table nears the completion of its return stroke, and a plurality of contact pieces are located in coacting relation with the switch lever. An electric circuit leads from a suitable source of energy and has one of its members passing through the coils of the electromagnet and terminating at one of the contact pieces, while its other member extends to and terminates at another contact piece, suitable electrical resistance being arranged in that member of the circuit terminating in the last-mentioned contact piece. When the apron is home in the tool-box, or, in other words, in cutting position, the armature stands away from the magnet poles, being suspended by the hangers, and the end of the set screw being in or nearly in contact with the face of the lever arm. If the electromagnet be sufficiently energized, then the armature will be drawn toward it, resulting in the pushing rearward of the lever arm and the swinging forward of the lower portion of the apron with the consequent elevation and relief of the tool. This action on the part of the electromagnet is to take place when the tool is to be lifted, the apron falling again and restoring the tool to cutting position when the magnet is deenergized. The cores of the spools are threaded directly into the metal of the tool-box, and the latter, therefore, forms the heel-bar of the magnet. The suspension device of the armature is of non-magnetic metal, and the pole-faces of the magnet or armature are armed with non-magnetic metal. The switching of the current to and from the electromagnet is effected by the dogs, adjustable along the planer table, which dogs may be the ones usually provided upon planers, the intention being that the magnet is inert while the table is making its cutting stroke, the current going to and energizing the magnet and lifting the tool just before the reversal of the table motion takes place, the tool being



TOOL RELIEF FOR METAL PLANERS.

held in elevated position of relief while the table is making its backing stroke and dropping again to cutting position by the deenergization of the magnet just before the table reverses at the beginning of the cutting stroke. The armature normally stands at some distance from the pole-faces of the magnet, and the work of initiating the tipping of the apron and tool is comparatively heavy, thus requiring such a strength of current as might damage the spools if maintained throughout the backing stroke of the planer. The attractive power of the magnet becomes greater as the armature approaches it, and when the armature shall have completed its active motion then the air-gap is practically nil, and comparatively little current may sustain the apron and tool in tilted position. By the arrangement of the contact pieces and the resistance, a reduction of the current strength is obtained, which strength is sufficient, however, to maintain the tool in lifted position without danger to the electromagnet.

The Interstate Independent Telephone Association.

THE Interstate Independent Telephone Association was organized in Chicago, Ill., April 9, 1902. About 500 telephone men gathered in the Sherman House, representing delegates from the states of Indiana, Illinois, Kentucky, Iowa, Wisconsin and Michigan. The greater number of these were practical exchange operators, and a large portion was made up of the manufacturers of telephones and kindred appliances. Dr. I. A. Lumpkin, of Illinois, was elected president *pro tem,* and delivered an address in which he spoke of the advantages of such an association as a means of bringing in closer touch the representatives of exchanges closely allied in the sister states involved in the organization. In the evening a banquet was tendered by the telephone manufacturers of Chicago, and over 500 attendants were seated at the tables. Informal toasts were responded to by a

H. C. RANEY, FAIRFIELD, IOWA, PRESIDENT OF THE INTERSTATE INDEPENDENT TELEPHONE ASSOCIATION.

number of telephone men, and the birth of what has proved to be an organization of great value to independent telephony was inaugurated under the most happy conditions.

On Thursday, April 10, permanent officers were elected, as follows: President, H. C. Raney, Fairfield, Iowa; vice-president, Dr. I. A. Lumpkin, Mattoon, Ill.; treasurer, J. C. Harper, Madison, Wis.; secretary, E. M. Coleman, Louisville, Ky. Executive committee—H. K. Cole, Owensboro, Ky.; J. B. Ware, Detroit, Mich.; Charles E. Hull, Salem, Ill.; George N. Bandy, Perry, Iowa; J. W. Layne, Carthage, Mo.; A. L. Hutchinson, Weyauwega, Wis.; L. A. Frazee, Connersville, Ind. Papers were read by Dr. C. F. Bennett, of Waterloo, Iowa; by Richard Valentine, of Janesville, Wis.; by H. C. Raney; by L. A. Frazee, of Connersville, Ind.; by E. M. Coleman; by E. R. Conklin, of Aurora, Ill.; by W. H. Crum, of Chicago; by A. L. Hutchinson, of Weyauwega, Wis., and by Dr. H. S. Herr, of Ottumwa, Iowa.

A committee was appointed to report

on the subject, "What Shall Be the Attitude of This Association to the Five and Ten-Cent Toll Men?" at the next meeting.

A subsequent meeting was held in Chicago by the officers of the association, and the date of the next meeting was decided on as December 9, 10 and 11. The place of meeting was determined by a committee, of which Dr. I. A. Lumpkin, of Mattoon, Ill., and Charles E. Hull, of Salem, Ill., were members.

The convention will make its headquarters at the Auditorium Hotel, and the apparent enthusiasm and interest which are being taken with regard to this occasion bid fair to make it one of the most valuable meetings which the independent telephone exchange operators have ever held. The programme which has been announced stands for much that will benefit the operator and the manufacturer of exchange apparatus alike.

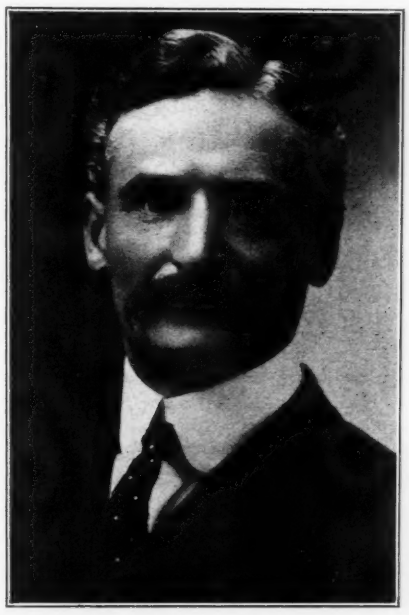
On Tuesday morning, December 9, a reception will be tendered to the visiting delegates by the executive committee and officers at the secretary's headquarters. At this time the place and hour of the banquet will be announced.

On Tuesday afternoon the address of welcome is scheduled for the Hon. H. S. Taylor, prosecuting attorney of Chicago. The response will be made by President H. C. Raney. The report of the executive committee will follow the president's address, when will be read the report of the secretary and the report of the treasurer. Following the custom decided upon at the first meeting, the selection of the nominating committee by states will be made, these to report on the call of the president.

On Wednesday morning, December 10, the manufacturers and supply houses of Chicago will take charge of the delegates.

On Wednesday afternoon, from 2 to 5 P. M., papers and discussion will be the order of the meeting. A paper by Mr. George N. Bandy, of Perry, Iowa, will be read, on "Rates-Measured Service." Dr. H. S. Herr, of Ottumwa, Iowa, will read a paper on "Sliding Scale Rates for Exchanges." "Toll Rates" is the subject of a paper to be presented by H. H. Robinson, of Cleveland, Ohio, followed by discussion. "Restrictions by Municipal Authority and Synopsis of the Law" will be explained by W. F. Laubach, Akron, Ohio; U. S. Alderman, Nevada, Iowa; J. C. Harper, Madison, Wis.; E. E. Webster, Minneapolis, Minn.; J. H. Ware, Detroit, Mich.; E. W. Pickhardt, Huntingburg, Ind.; M. Savage, Champaign, Ill.; H. Linton Reeber, St. Louis, Mo.; D. L. Pendleton, Winchester, Ky.

Thursday morning will be given up to the reading and discussion of papers from 9 to 12 A M. The papers announced are as follows: "Settlement of Toll Business Between Connecting Companies," by A. L. Hutchinson, Weyauwega, Wis.; "Enforcement of Message Time Limit," H. E. Ralston, Maitland, Mo.; "Independent Telephone Securities as an Investment"—(*a*) "From a Banker's Standpoint," Colonel J. D. Powers, Louisville,



J. C. HARPER, MADISON, WIS., TREASURER OF THE INTERSTATE INDEPENDENT TELEPHONE ASSOCIATION.

Ky.; (*b*) "From a Small Investor's Standpoint," J. H. Layne, Carthage, Mo.; "The Berliner Patent, Bell's Claims of Infringement, and Litigation now Pending," J. J. Nate, Chicago, Ill.; "Suggested Methods for Improving Long-Distance Telephony," Senator C. E. Hull, Salem, Ill.

On Thursday afternoon the manufacturers and supply houses will entertain the attending delegates.

All persons who attend the meeting should secure certificates from railway agents where tickets are purchased. This certificate entitles them to a one-third fare on the return trip. If through tickets can not be secured from the starting point, a certificate should be secured from each agent where the ticket is purchased. These certificates should be presented to E. M. Coleman, secretary, at the Chicago meeting for endorsement.

New Telephone Apparatus—I.

Descriptions and Illustrations of the Latest Types of Telephone Instruments and Telephone Accessories.

Central Energy Telephones for Mines and Interurban Railways.

A new central energy mine and railway set, which is especially designed to meet the conditions of bad weather, hard usage and places where high-potential currents abound, is shown in Figs. 1 and 2. This outfit is made by the Stromberg-Carlson Telephone Manufacturing Company, Chicago, Ill., and Rochester, N. Y. The iron box which protects the telephone proper is claimed to be weather-proof and absolutely water-tight. The line connections are brought into the box through a double elbow, at the top, as shown, thus eliminating any chance of water coming in contact with any connections in the box. The mechanism is completely protected by the inner case, which is locked and only accessible by the person having charge of the maintenance of the system. The various parts of the apparatus are mounted on the inside of the inner case door, and when it is open reveals all parts in a manner that is convenient for inspection, test or repairs. The equipment of a single telephone consists of one S.-C. long-distance transmitter, one S.-C. bipolar receiver, platinum contact hook-switch, metallic carbon and fuse lightning-arrester connectors and all necessary parts for the complete operation of a central energy system. All metal parts are non-corrosive, all circuits are wired with the best grade of rubber insulated wire and all parts are interchangeable.

The line cutout is provided when specified, and is intended as an absolute line disconnecter when the receiver is hung on the switch-hook and the outer case door closed; this makes it impossible for any high-potential current arcing to take place in the case when the apparatus is not in use, the carbon and fuse arrester being permanently connected to outgoing lines.

That part of the equipment shown in Fig. 3 is known as the cut-in station, and is intended for use in connection with the instruments already described and shown in Figs. 1 and 2. This box is weather-proof, provided with hinges and lock and made of heavy cast iron. It is so constructed that it may be used without unlocking. In the lower end of the box an opening is provided with a self-closing trap door, which may be opened by pressing upward. This equipment consists of a bridging-jack with heavy German silver reenforced springs and mounted on a heavy, hard-rubber base and with heavy sleeve for plug guide, the tension of the springs being sufficiently strong to retain the plug firmly in position and assuring perfect electrical contact. On the bottom of the box there is a "Y"-shaped guide or groove which forms a path for plug to the opening in spring-jack sleeve, thus making it convenient for the user to insert plug into the jack. The mere insertion of the plug calls the despatching operator or headquarters.

The instrument bids fair to become a very popular instrument with street railway people, and it is understood that the company has a number of contracts already executed for this line of apparatus.

FIG. 1.—WEATHER-PROOF CENTRAL ENERGY INSTRUMENTS FOR MINES AND INTERURBAN RAILWAYS.

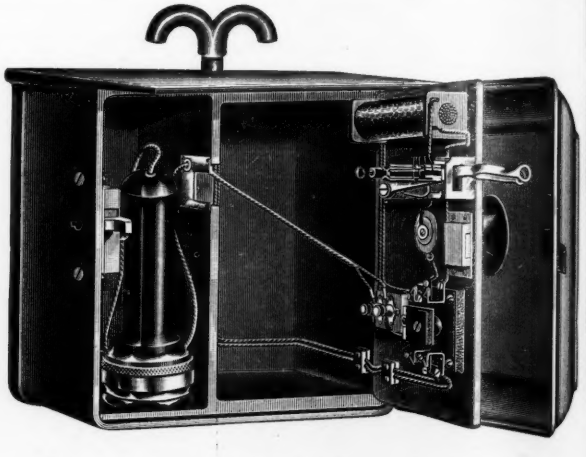


FIG. 2.—INTERIOR OF CENTRAL ENERGY INSTRUMENTS FOR MINES AND INTERURBAN RAILWAYS.

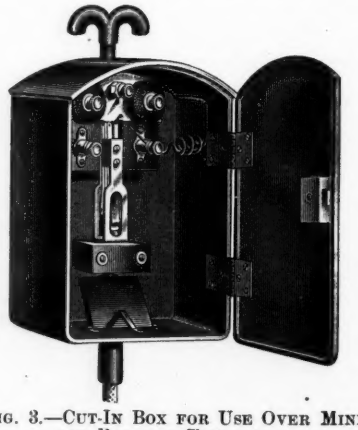


FIG. 3.—CUT-IN BOX FOR USE OVER MINE AND RAILWAY TELEPHONE.

Recent Installation of Automatic Telephone Apparatus.

The Northeastern Telephone Company, which was recently reorganized with headquarters at Portland, Me., has given to the Automatic Electric Company, of Chicago, an order for an automatic switchboard of 10,000 capacity with an initial installation of 2,500 stations for the city of Portland.

The Northeastern company has purchased a building site in the business centre of the city, and its architects are preparing plans for a building which shall be arranged in such a manner as best to accommodate the automatic exchange. The exchange will be so located that 40,000 people can be reached within a radius of one and one-half miles.

This fact and that of the rapid growth of Portland during the ten years past has led the company to prepare for a large increase, and its officials believe that within twelve months after the opening of its exchange for business, and the people generally become acquainted with the service, they will have 3,500 stations connected up.

Solid-Back Long-Distance Transmitters and Intercommunicating Telephones.

This transmitter is constructed upon the latest principles of modern telephony. The metal and carbon diaphragms are held in place with German silver springs, while the back carbon electrode is held in place by a heavy cast brass spider, which in turn is supported by three lugs on the transmitter front.

The granular carbon used in this transmitter is specially ground and prepared. The diaphragm is manufactured under special conditions and in a manner entirely exclusive with the company making them, which does away with all buzzing and ringing tones and makes it thoroughly moisture proof. The stamped back or cover is attached in such a manner that no screws appear on the outside of the entire transmitter.

This transmitter is strongly constructed and yet remains sensitive to the most delicate sound. It is claimed to

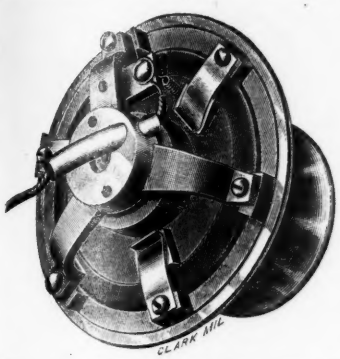


FIG. 1.—BACK VIEW, SOLID-BACK LONG-DISTANCE TRANSMITTER.

operate with small battery power and at the same time withstanding a variation in current without generating any disagreeable frying or scratching noises. The articulation is clear and loud, the natural tones and expression of the voice being clearly transmitted. No device is necessary for agitating the carbon, and the transmitter is especially designed to prevent packing. Fig. 1 is a back view of the solid-back long-distance transmitter.

The manufacturer of this apparatus also makes a combination desk telephone for use in connection with automatic wall telephones. This makes a very complete and convenient interior telephone system. The switch box is placed on the end of the desk out of the way and avoids the shoving aside or mixing of papers, letters, etc., when the telephone is used.

This apparatus is fitted with the solid-back long-distance transmitter described above, and is also equipped with an automatic switch arrangement and signaling buttons. This automatic arrangement does away entirely with plugs, levers, and operators' central offices. A rubbing contact is provided for each switch. The connection is made by pushing a hard rubber button, which is released automatically. The apparatus is encased in an oxidized box attached to the back of solid oak. German silver contact springs fitted with platinum points are used exclusively. All other parts are made of brass, heavily nickel-plated.

FIG. 2.—FRONT VIEW OF LONG-DISTANCE SOLID-BACK TRANSMITTER.

This apparatus is manufactured by the Green Telephone and Electric Manufacturing Company, Milwaukee, Wis.

A Private Line Battery Call Telephone.

In the manufacture of this instrument the maker has exercised more than usual care in this style of telephone. The apparatus is equipped with the standard long-distance transmitter with horseshoe

PRIVATE LINE BATTERY CALL TELEPHONE.

magnet, bipolar receiver, the receiver cord having concealed cord terminals and so arranged that no strain whatever is brought to bear on the tinsel cord conductors. The engravings plainly show that the instrument is furnished with double gong bells and the ringer movement is of easy adjustment.

The hook switch is of the self-contained type and the contact springs are made of German silver.

These telephones are wired for private line service employing local transmitter batteries, or for hotel system use in connection with telephone annunciators, employing a common battery. Each part is carefully made and assembled in the neatest possible manner. The cabinets are made of walnut or quartered oak, as desired. This apparatus is manufactured by the Sumter Telephone Manufacturing Company, Sumter, S. C.

Complimenting Mr. Pope.

On October 4, with the completion of the new "North" exchange, at Buffalo,

INTERIOR VIEW, PRIVATE LINE BATTERY CALL TELEPHONE.

the reconstruction and extensions of the plant of the Bell Telephone Company, which have covered a period of three years, were completed. Mr. H. W. Pope, the acting general manager, who has been continuously in charge of this work during this time has been assigned to other duties at the headquarters of the parent company, the American Telephone and Telegraph Company, in New York. Previous to his departure he was given a banquet at the Iroquois Hotel, in Buffalo, by departmental officials and presented with a handsome silver loving cup with appropriate inscriptions and the names and titles of the officials engraved thereon. The general manager's office force presented him with a gold-headed cane. Each of the gifts was accompanied by a letter setting forth their appreciation of Mr. Pope and wishing him every success in the future.

Telephony at the Meeting of the Chicago Academy of Sciences.

The regular monthly meeting of the Chicago Academy of Sciences, held in the auditorium of Laflin Memorial Hall, in Lincoln Park, Chicago, Tuesday evening, November 25, was devoted to study of the new telephone system which is being installed in that city. The auditorium was filled by members of the academy and their guests, who had gathered to listen to papers upon the construction of the tunnels of the Illinois Telephone and Telegraph Company; the automatic telephone and switchboard with which the Chicago exchange will be equipped, and to witness the operation of automatic telephone instruments which Mr. A. E. Keith, superintendent of the Automatic Electric Company, had placed in the hall for use upon this occasion.

Mr. George W. Jackson, chief engineer of the Illinois Telephone Construction Company, which is constructing the great conduits under Chicago, read a paper illustrated with numerous lantern slides, describing the work on the tunnels, its progress, the methods employed in building, and the manner of installing cables and distributing wires. Toward the close of his paper, Mr. Jackson added some new and very interesting ideas upon the lowering of the present street railway tunnels which threaten navigation of the Chicago River, and also upon a new system of sewers for Chicago. He was listened to with marked attention, because of his broad and practical experience in great enterprises of this kind.

Mr. J. F. Crook, of the Automatic Electric Company, followed Mr. Jackson with a paper upon the automatic telephone system, and the features which the manufacturer claims make it superior to the present manual telephone systems. Mr. Crook used lantern views to illustrate the apparatus of his company. Toward the close of his remarks he reproduced for comparison views of the manual exchange with the operators seated along the switchboard, and of the automatic exchange in which the automatic switches entirely displace the "Hello Girl."

Mr. Keith, who was present, then invited those who were interested to use the telephones which had been installed in different parts of the room, and in the alcoves of the library. He also requested those who wanted any points in regard to the operation or construction of the instruments cleared up, to feel free to ask any questions of him, and for a while all were busily engaged.

Mr. Jackson said in the course of his remarks that within eight months his company proposed to have an exchange operating in the central districts of Chicago.

Recent Interesting Telephone Installations.

The Trenton (N. J.) common battery switchboard, having a capacity of 5,000 lines, has been completely installed and placed in operation. The Interstate Telephone Company is well pleased with the operation of the equipment, which, in addition to the usual common battery apparatus, includes a toll board, chief operator's desk, wire chief's desk, etc.

The Keystone Telephone Company's toll board has been put in operation at Philadelphia. This board is one of the largest toll boards ever built, consisting of a twenty-position equipment. In addition to the main switchboard there are provided a chief operator's desk, a two-position record operator's desk, etc. Each section of the main board is equipped with calculagraphs.

The Texarkana (Tex.) switchboard, having a capacity of 2,500 lines, has been installed and was put in operation November 1. This board was put in operation just sixty days after the order was received, and the completion of the equipment in this short space of time is one of the most rapid pieces of work up to date, considering the size of the equipment.

The installation of the Springfield (Mo.) switchboard, a 2,400-line-capacity equipment, is rapidly nearing completion and is about ready for operation.

The Jackson (Tenn.) and Paducah (Ky.) equipments, comprising, respectively, 2,000 and 3,000-line equipments, are about completed, and efforts are being made to place the above boards in operation before January 1, 1903.

This apparatus has all been designed and completely installed by the American Electric Telephone Company, of Chicago, Ill.

The Design of Alternating-Current Transformers.

The current number of the *Journal of the Worcester Polytechnic Institute* contains the first of a series of articles on "Alternating-Current Transformers," by Professor Harold B. Smith. In this section the fundamental parts of a transformer are defined, and the end to be sought in each case is pointed out. The constant-potential transformer is then taken up and the design of the core discussed in detail, comparisons between different types being made. This series of articles promises to be a great help, both to the student and the designer.

New Type Non-Interfering, Intercommunicating Desk Telephone.

Many features are claimed for the instrument herewith illustrated which mark it as a distinct advance in telephone construction. Among the notable features which characterize this apparatus are the following: The instruments are entirely self-contained. The jacks, buzzer and all connections are located directly in the base. The system is absolutely non-interfering, the trace of cross-talk which is sometimes found in the ordinary intercommunicating system being entirely eliminated. A new spring jack is used, ensuring perfect contact. It is not necessary to return the plug to a home station or any particular point when through using.

All binding-posts and screws are entirely done away with. The upright is

NEW TYPE NON-INTERFERING INTERCOMMUNICATING DESK TELEPHONE.

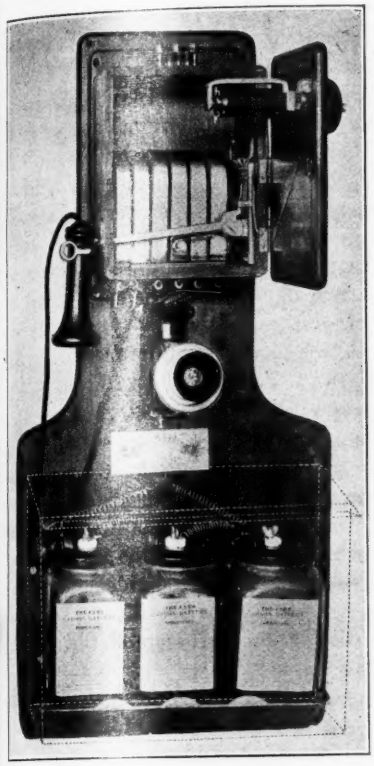
made entire, of one solid casting, giving great durability. The transmitter is of the latest type, having solid enclosed back and being especially designed for these systems. The receiver is made on the latest model, having concealed binding-posts.

Silk receiver cord and silk cable, containing all wires seven feet long, are furnished with each instrument. The metal base of the instrument can be readily removed to allow inspection of buzzer, etc.

The manufacturer of this apparatus, the Allen-Hussey Company, of Chicago, Ill., has recently moved to larger and more commodious quarters in the heart of the telephone district. This company makes a specialty of manufacturing interior telephones for banks, offices, hotels, etc. The office and factory of the company is corner Jackson Boulevard and Clinton street.

Bridging Telephone and Generator for Heavily Loaded Lines.

The accompanying illustration shows a new design of bridging telephone, intended for long country lines which are heavily loaded with instruments. The magnetos are of the very strongest kind,



Bridging Telephone and Generator for Heavily Loaded Lines.

being made up of six bar magnets and laminated armatures, and will ring through 150,000 ohms resistance. This generator has current enough to light up one sixteen-candle-power Edison lamp made for 110 volts. The ringer coils are wound to 1,600, 2,000 and 2,500 ohms. The transmitter is made after the Bell type, solid-back style. The apparatus is equipped with a bipolar receiver, three carbon batteries and a long English hook provided with safety switch springs, self-contained.

This apparatus is manufactured by the Farr Telephone and Construction Supply Company, of Chicago, Ill.

Induction Motors in a Wood-Working Establishment.

An interesting example of the application of induction motors to the driving of shop machinery is afforded by the plant of William Demuth & Company, Brooklyn, N. Y., manufacturer of tobacco pipes and walking sticks. The plant is situated a short distance from Park avenue, in East New York, and consists of two buildings—a three-story brick factory, 200 by 600 feet, and a small brick power-house building, at a short distance of but a few feet from the factory.

The original intention of the operators of the establishment was to make use of direct current from the distribution system of one of the Brooklyn power companies, but a polyphase alternating system was finally installed on account of its many attractive features. Power for the factory is furnished by two Westinghouse two-phase, compensated-field alternators, driven by Corliss and Ball & Wood engines having a close speed regulation. Excitation is furnished by small multipolar dynamos driven from the main generator shafts. The switchboard contains three panels for generators and feeders. The main power system operates at 220 volts, and all motors are wound for this pressure. Lighting is also supplied from the two-phase mains, special balancing transformers being introduced between the 220-volt leads for the purpose of furnishing a 110-volt, three-wire lighting service and equalizing unbalanced loads upon the lighting system.

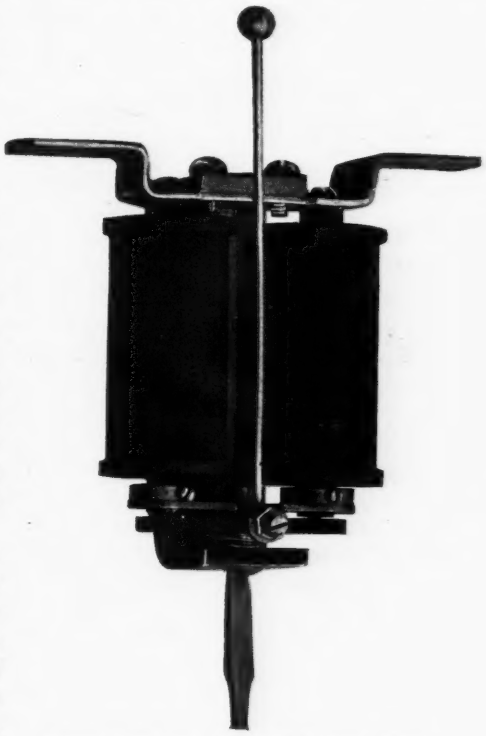
Motive power in the factory is furnished by fourteen Westinghouse type C induction motors varying in capacity from five to twenty horse-power. The majority of these motors are mounted overhead upon wooden sleepers bolted to the beams of the floor above. They require no care further than an occasional replenishing of the oil wells. Many of the motors operate in an atmosphere heavily laden with wood dust from the wood-working machinery, and are completely covered with this oil-soaked dust, but show no injury therefrom. The motors are belted to short-line shafts, which in turn drive various types of belted machinery, including turning and mounting lathes, circular and band saws, buffers, blowers, drill and machine-shop tools.

The motors are started at a reduced voltage by means of Westinghouse starting coils, and when near synchronous speed are thrown directly upon the 220-volt system. The power equipment has been in operation for over one year, and has been thoroughly satisfactory in every respect.

Book Review.

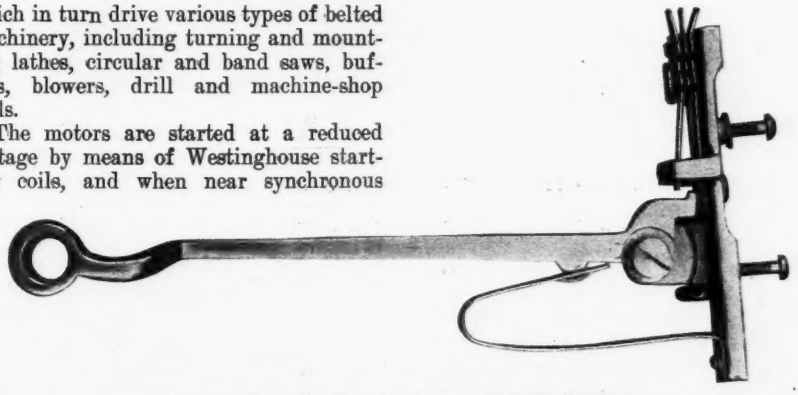
"Transactions of the American Electrochemical Society." Philadelphia. The American Electrochemical Society. Cloth. 274 pages. 6 by 9¼ inches. Illustrated. Supplied by the Electrical Review at $3.00.

This is the second volume of the transactions of the society, and contains in full the papers presented at the meeting



Ringer Coil for Heavily Loaded Line.

held at Niagara last September, with discussions. These papers have already been published in abstract and need no comment here. The list of members, as printed, shows that the society is growing steadily. This list includes a goodly number of well-known names of American and foreign scientists. The volume is neatly bound and well indexed.



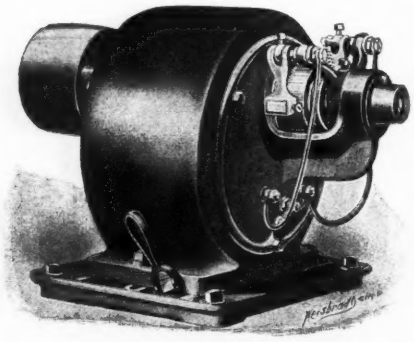
Long English Hook with Safety Switch Spring.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

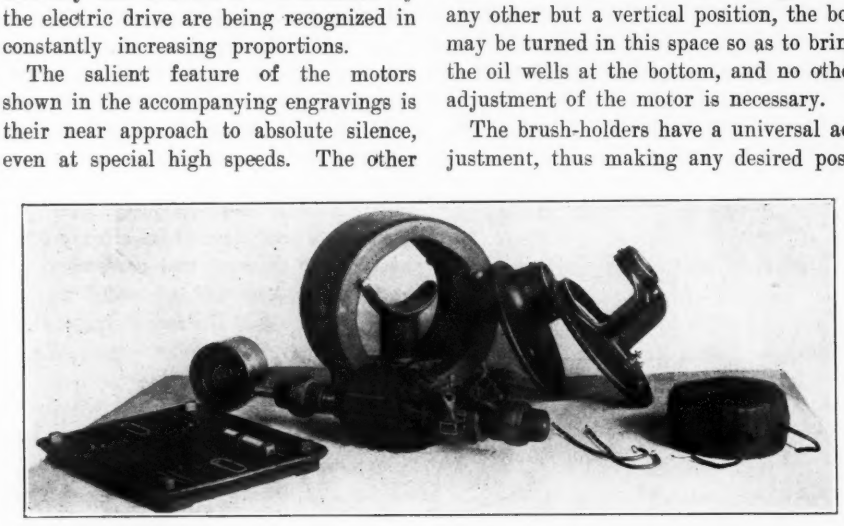
Shielded Type Direct-Current Motors.

The rapid increase in the adoption of the electric motor for a great many varieties of work which require silent and easy-running mechanism is being met by the motor builder with continued success. Following the work of the central station operator, the electric current is being introduced more completely into new and old buildings, and the economy and convenience established by the electric drive are being recognized in constantly increasing proportions.



SHIELDED TYPE DIRECT-CURRENT MOTOR.

The salient feature of the motors shown in the accompanying engravings is their near approach to absolute silence, even at special high speeds. The other distinctive features are the even running bearings, and the cool operation and absence of vibration.



SHIELDED TYPE DIRECT-CURRENT MOTOR, DISASSEMBLED.

The yoke bearings, armature head and each individual part are positively interchangeable. The motor is so constructed that it may be fastened to a column, side wall, or suspended from the ceiling. The armature is made of stampings of specially prepared steel sheets, which are thoroughly annealed in the shops just before the final assembling. The new design of the motors dispenses with binding wires, the conducting wires being held in the slots by strips of bamboo. The shaft is of a high-grade spindle steel stock, made rigidly and gauged.

The commutator is much larger than is usual in proportion to the rest of the motor. It is composed of hard-drawn copper bars, insulated with pure mica, both between segments and on the ends. The bars are pressed very solidly together by being forced into a ring by hydraulic pressure, and after finishing, by being dove-tailed between heavy iron collars. These collars may be tightened up at any time should the mica become loosened in service.

The bearings are of either phosphor-bronze sleeves or genuine babbitt metal, laid in cast-iron boxes, which contain the usual oil wells and rings. These cast-iron boxes swing on a ball-shaped seat in the motor heads, and are thus self-aligning. When it is desired to mount the motor on the side wall or ceiling, or in any other but a vertical position, the box may be turned in this space so as to bring the oil wells at the bottom, and no other adjustment of the motor is necessary.

The brush-holders have a universal adjustment, thus making any desired position easily attained. There are no sliding contacts to the carbon or holders. A rectangular high-grade carbon or graphite brush is used. The pulleys are either flat or grooved, and range from two inches to six inches in diameter.

The yoke is made of special, peculiar electric iron, which is very dense and even and has a high permeability, securing a uniformity of performance in the machine. This being a unique feature in electric motor design, it was slowly developed through experimental stages and is said to be giving entire satisfaction in its mechanical and electrical qualities.

These motors are subjected to a rigid test and the finished machine is given a long run under normal load and voltage. Then the voltage is raised and the load increased, in most cases, by 100 per cent. During this test, each machine is tested at regular periods for correct performance at the commutator, oil rings, bearings, fields and armatures. The current is then shut off from the machine and its temperature is gauged.

These motors are manufactured by the Sterling Electric Motor Company, of Dayton, Ohio.

The Electric Storage Battery Company, of Philadelphia, has recently closed a contract with the Baltimore & Ohio Railroad Company for the installation of a second battery of chloride accumulators to be operated at the Mount Royal entrance of the Baltimore & Ohio tunnel, Baltimore.

The first battery was installed in November, 1900, in a building which was designed for the installation of two batteries, and the second battery was put in as the result of the successful service which has been obtained from the original plant. The Baltimore & Ohio Railroad Company has completed its plans for the electric haulage through the tunnel of both its freight and passenger trains, and for this purpose has contracted for two electric locomotives of approximately double the capacity of the ones now in service. The demand which will be occasioned by this increased service necessitated a corresponding increase in the power equipment, and it was decided that the best way of obtaining this was by the installation of another battery.

Before the first battery was installed, the load required at times the operation of three 500-kilowatt generators. On the installation of the original battery this number of generators was reduced to one, and it is estimated that even with the increased service of the heavier locomotives and the more frequent trips, the larger capacity in battery output will still admit of the entire work being done by the same generator.

Three hundred and twenty cells of chloride accumulators, type G-25, will be operated in parallel with the original battery, giving a total battery output of 2,500 amperes.

New Weather-Proof Sockets.

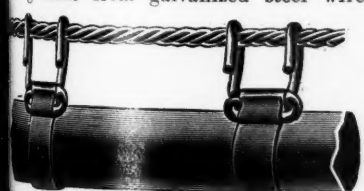
The porcelain weather-proof socket shown in the accompanying engraving has recently been placed on the market, and possesses features which make it of especial value in this service. The design is based upon the idea of a petticoat insulator, and practically consists of a standard weather-proof socket with a surrounding hood, all in one piece, made of the highest quality of glazed porcelain. The hood acts as a reflector, actual tests showing fifty per cent more light when the socket is used, besides keeping the falling rain and soot from dimming the lamp. The manufacturer, the H. T. Paiste Company, Philadelphia, announces that it has ready to place upon the market the plain pendent type, together with bracket types adapted for both one-eighth and three-eighths-inch bases. The trade name for this new weather-proof socket, following the general character of its goods, is P-K deep grooved.

WEATHER-PROOF SOCKET.

A New Double-Grip Cable Hanger

In the accompanying illustration is shown a new double-grip cable hanger, which, while on the market but for a short time, is claimed by the manufacturer to have become very popular because of its peculiar construction, and has been adopted by several of the largest telephone companies in America.

This is a two-piece hanger, the hook being made from galvanized steel wire and a strip of zinc. It is adjustable to any size cable, and is claimed to be absolutely rigid and immovable when once fastened to the cable. It possesses the additional feature of being adjusted with great rapidity and is put up without the use of tools of any kind.



HOFFMAN DOUBLE-GRIP CABLE HANGER.

This cable hanger is manufactured by the Greer Electric Company, Nos. 60-66 West Van Buren street, Chicago, Ill.

The Pacific Cable.

The accompanying illustration shows the operation of laying the first strip of the San Francisco-Honolulu cable for the Commercial Pacific Cable Company. The group surrounding the cable reel is composed of electricians, cable experts, government experts and members of the staff of the Commercial Pacific Cable Company. Mr. Charles Cuttriss, electrician for the cable company, is among the group, and Mr. L. G. Martin, cable expert of the Okonite Company, is also present. This is an important section of the cable now being laid from San Francisco to China, and is being constructed under the imposed conditions that it shall be an all-American through line from the United States to the Asiatic continent.

The conditions surrounding the arrangement between the government and the company have been modified in but one instance from those originally laid down. This was the provision providing for American operatives. The company has asked that it be changed to read American operatives "when obtainable."

The charts now ready carry the cable beyond the Hawaiian Islands to the Midway Islands, and from there to Guam. From Guam, two links will extend—one to the Philippines, and the other to China. It is stipulated that the cable shall touch at no other than American territory on the route from the United States to the Chinese Empire. The line from the Philippines is to be constructed in one year by the company. The government of the United States, through its officers or agents, is to have priority with its telegrams over all other business, and the United States shall have at all times a right to purchase the cable lines, and is also to have authority to assume full control of the cable during war, including grave civil disturbances or when war is threatened. The cable must be capable of transmitting not less than twenty-five words per minute, and the company has agreed to make every effort to maintain this standard.

All of the land lines of the cable have been manufactured at the works of the Okonite Company, at Passaic, N. J. Mr. Willard L. Candee, of the Okonite Company, has left New York to be present at the laying of the land lines, both in San Francisco and in Honolulu.

THE FIRST REEL OF THE LAND LINE OF THE PACIFIC CABLE.

The American Association for the Advancement of Science.

The fifty-second annual meeting of the American Association for the Advancement of Science and the first of the convocation week meetings will be held in Washington, D. C., December 27, 1902, to January 3, 1903. The meeting of the executive committee of the council, consisting of the general secretary, the secretary of the council, the permanent secretary and the secretaries of all the sections, will be held in the council rooms of the Cosmos Club, at noon on Saturday, December 27. The opening session of the association will be held at 10 A. M. on Monday, January 3, in Lafayette Theatre. Most of the sections of the affiliated societies will meet in the buildings of the Columbian University. A rate of one fare and one-third has been secured for all persons attending the meetings, and tickets may be purchased from December 15 to January 3, and will be accepted until January 15. Dr. Marcus Benjamin, of Columbian University, 1420 H street, Washington, D. C., is the local secretary. The hotel quarters of the association will be the Arlington Hotel.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

LARGE POWER PLANT TO BE LOCATED AT LONG ISLAND CITY—It has been stated that the Pennsylvania Railroad is to erect an enormous power-house in Long Island City. This is to operate the trains in the East River tunnel and all the suburban trains leaving Long Island City. The cost is estimated at $5,000,000.

SUSQUEHANNA POWER PROJECT TAKES SHAPE—Preliminary steps in the plans of the Susquehanna Electric Power Company to harness the Susquehanna River have been taken in the formation of the Conowingo Land Company, of Cecil County, which has been incorporated with a capital stock of $60,000. The incorporators of the company are: George C. McGaw, of Baltimore; James H. Harlow, of Pittsburg, Pa.; James E. Warder, of Baltimore, and Charles C. Caldwell, of Liberty Grove. The principal office will be at Conowingo. The company has purchased property containing about 1,100 acres for $50,000. The Susquehanna project will mean an outlay of from $8,000,000 to $10,000,000. The fall of water at Conowingo, it is estimated, is sufficient to furnish at least 100,000 horse-power.

PHILIPPINE ELECTRIC RAILWAY FRANCHISE BILL PASSED—The Philippine Commission in open session has taken final action on the franchise bill, which is now a law, and which is expected to furnish Manila with an electric railway in the near future. The bill provides that the bidding for the franchise be left open until March 5, 1903, and the commission will advertise both in the Philippines and in the United States that the franchise will be granted. The franchise will also allow the company receiving the same to supply the city with electric lights. Sixty per cent of the cars used are to be second-class cars, the balance first-class cars, and the bill regulates that bidders must agree to furnish first-class transportation for not more than seven and one-half cents gold, no bids to be considered that are in excess of that amount. At the end of twenty-five years from the opening of operation there may be a readjustment of fares should necessity require the same.

A LARGE WESTERN RAILWAY MERGER—Announcement has been made of a deal whereby the Pike's Peak Power Company and the Pueblo Traction Company, owning the street car system in Pueblo, Col., are merged into a corporation under the name of the Pueblo Suburban Traction and Lighting Company. Among its numerous projects is said to be an electric line from Pueblo to Colorado Springs. The new company is capitalized at $3,500,000, and the incorporators are: Mahlon D. Thatcher, president of the First National Bank of Pueblo; Ward Rice, cashier of the Pueblo Savings Bank; T. H. Devine and John F. Vail, general manager of the Traction company. H. E. Woods, Warren Woods and F. M. Woods are also interested. The Pueblo Traction Company owns practically an exclusive franchise for street-car lines in Pueblo. A fine system is already in operation and a great many improvements have recently been made to the equipment. One of the handicaps of the system has been lack of power, and it is said that to secure this was one of the reasons for effecting the merger. Surveyors are to be set to work immediately locating a line from the Pike's Peak Power Company's turbine water plant on Beaver Creek, thirty-five miles west of Pueblo. It is expected to have it connected with the Pueblo plant by May 1, and a 1,700-horse-power current from there connected to the 2,000-horse-power plant of the Pueblo Traction Company. It is the intention of the company not only to furnish light and power for Pueblo and Pueblo County, but for other points in Teller, Fremont and Otero counties and the region around Pueblo, and possibly in El Paso County. The plant on Beaver Creek is already furnishing 1,000 horse-power to Victor and other places.

MANHATTAN ELEVATED RAILWAY COMPANY THE SUBJECT OF A LEASE—The formal announcement of the completion of negotiations by which the Manhattan Railway Company will be leased by the Interborough Rapid Transit Company for a period of 999 years has been made, following the meeting of the boards of directors of both companies last week. The lease will take effect on April 1, 1903, to be for 999 years, and to cover all the franchises and property of the Manhattan Railway Company. The rental from April 1, 1903, to January 1, 1906, will be the net earnings of the Manhattan company, not exceeding seven per cent; after January 1, 1906, the rental will be seven per cent per annum on the stock of the Manhattan Railway Company, guaranteed by the Interborough Rapid Transit Company. The Manhattan Railway Company's stock is to be increased at once to $55,200,000 for the purpose of completing improvements already planned, the present stockholders of the Manhattan company to have the privilege of taking the new stock pro rata at par. Provision is to be made in the lease for an ultimate increase (but not before three years) of Manhattan stock to the total amount of $60,000,000, including outstanding stock; and due provision is to be made for the application of the proceeds of the sale of the increased stock to the further improvement of the Manhattan property. The Interborough company will pay $10,000 per annum to keep up the organization of the Manhattan company, in addition to the dividend rental which shall be paid to the stockholders, and the Manhattan stock will be stamped with a contract of the Interborough company to this effect. In addition to its capital stock, the Manhattan company has out about $40,000,000 of bonds. It owns about thirty-eight miles of double-track road, and has a number of franchises in the Bronx which have not been built on and may be utilized by the subway people under the new lease. The Rapid Transit Subway Construction Company, which is constructing the rapid transit tunnel, has $6,000,000 capital stock, while the Interborough Rapid Transit Company, which was formed originally to own and operate the subway on its completion, has a capital of $30,000,000 common stock. The company has no bonded indebtedness, the only obligation ahead of the common stock being a payment of three and one-half per cent yearly on $37,000,000 to the city, and a sinking fund of one per cent, the latter to commence five years after the road is in operation. The larger part of the capital to build the Brooklyn extension has been furnished by the Interborough company, as it was deemed better to use its capital this way than to accept further advances from the city.

LEGAL NOTE.

FINAL DECREE HANDED DOWN IN FAN MOTOR SUIT—Judge Lacombe, in the Circuit Court of the United States for the Southern District of New York, held at the city of New York on November 17, handed down a decree in the suit of the Diehl Manufacturing Company *vs.* the Dayton Fan and Motor Company, Ernest A. Lowe and Charles W. Leveridge. The decree states that claims one and two of letters patent of the United States No. 414,757, granted to Philip Diehl on an electric fan motor, November 12, 1889; claims two and four of letters patent of the United States No. 414,758, granted to Philip Diehl on an electric fan, November 12, 1889; claims one three, four and five of letters patent of the United States No. 465,360, granted to Philip Diehl and Edwin H. Bennett, Jr., on an electric fan, December 15, 1891; claim six of letters patent of the United States No. 465,361, granted to Philip Diehl and Edwin H. Bennett, Jr., on an electric fan, December 15, 1891, and claims one and five of letters patent of the United States No. 585,250, granted to Edwin H. Bennett, Jr., on a combined electric fan and electrolier on January 20, 1897 (being all the claims put in issue by the proofs) are, and each of the said claims is, valid, and the title to the said five letters patent is vested exclusively in the complainant, the Diehl Manufacturing Company, and the defendants, the Dayton Fan and Motor Company, and Lowe and Leveridge, and each of them, have infringed said eleven claims of said letters patent, the Dayton Fan and Motor Company by making and selling, and Lowe & Leveridge by selling in the United States electric fan motors using the invention covered by said eleven claims. It is decreed that a permanent injunction be issued out of this court, commanding and enjoining the said defendants from hereafter directly or indirectly making, using or selling the invention covered by these claims without license or permission of the complainant. The defendant, having satisfied and paid all claims and demands for the profits, damages and costs, it is further decreed that this decree be without reference for the ascertainment of the same.

ELECTRICAL SECURITIES.

The bank statement of last week showed a considerable increase, amounting to almost $12,000,000, in the loan account. This was not looked for generally and had a decidedly unfavorable effect on subsequent dealings. The response to this adverse showing was a partial break in what was up to this time a comparatively strong market, although the speculative demands were in no way extravagant. The stocks in general lost ground, and in some cases the declines ran up as high as two points in leading issues. Earlier in the week the strong showing of several local issues brought the market up in fairly good shape, and the anticipation of a favorable message from the Executive convinced a great many speculators that bull conditions were likely to be found in favor for some little time. The coming message to Congress from the President will be of more importance than usual, as the Executive is regarded in the financial district more or less as an unknown quantity. For several months Wall street has been fearful that the administration will force Congress to consider in some radical way anti-trust legislation and tariff revision. Consequently, it will derive much encouragement from a temperate message. It is very evident that the financial district is desirous of moderate measures regarding the various railroad and industrial combinations, and if the President recommends these things it will be of the greatest encouragement to speculative conditions in general.

ELECTRICAL SECURITIES FOR THE WEEK ENDING NOVEMBER 29.

New York:	*Closing.*
Brooklyn Rapid Transit	63⅞
Consolidated Gas	213
General Electric	178
Kings County Electric	211
Manhattan Elevated	156½
Metropolitan Street Railway	139⅞
New York & New Jersey Telephone	161
Westinghouse Manufacturing Company	208

The official announcement of the terms of the Manhattan Elevated lease to the Interborough company was the principal news item of the week in local securities.

Brooklyn Rapid Transit earnings show an increase of $433,387 for the four months ending October 31, over the same months in 1901.

The Westinghouse Electric and Manufacturing Company has declared a quarterly dividend of 1¾ per cent upon the preferred stock of the company, payable January 2, 1903.

The directors of the Consolidated Gas Company have declared the regular quarterly dividend of 2 per cent, payable December 15.

Boston:	*Closing.*
American Telephone and Telegraph	159½
Edison Electric Illuminating	267½
Massachusetts Electric preferred	96
New England Telephone	137
Western Telephone & Telegraph preferred	97

The gross earnings of the Boston Elevated Railway Company for the year ending September 30 are $11,321,030, as compared with $10,792,993 for the year previous. For the year 1899 and 1900, the gross earnings were $10,141,209, and in the year 1898 and 1899, they amounted to $9,671,440.

Philadelphia:	*Closing.*
Electric Company of America	9½
Electric Storage Battery common	80
Electric Storage Battery preferred	80
Philadelphia Electric	8¾
Union Traction	47
United Gas Improvement	111

Chicago:	*Closing.*
Edison Light	175
Chicago Telephone	156
Metropolitan Elevated preferred	85
National Carbon common	27
National Carbon preferred	95
Union Traction common	14
Union Traction preferred	50

The regular dividend of the Chicago Telephone Company will probably be declared at the meeting of the directors of the company early in December.

The directors of the South Side Elevated have declared the regular dividend of 1 per cent, payable December 31.

PERSONAL MENTION.

MR. W. C. WOODWARD, a well-known electrical engineer of Providence, R. I., was a visitor in New York last week.

MR. J. BEYERS HOLBROOK, M. E., on December 1 became a member of the firm of Charles Henry Davis and Partners, of New York city.

MR. CHARLES AUSTIN ROLFE, of the American Electric Fuse Company, of Chicago and Adrian, Mich., was a New York visitor this week, renewing old acquaintanceships in the East.

MR. EDWIN R. KNOWLES, New York city, has been retained as consulting engineer with the St. Lawrence Power Company. Mr. Knowles has just returned from a trip of inspection of the power plant at Massena, N. Y.

MR. L. W. KITTMAN, Chicago, will act as general traveling representative for the Marshall-Sanders Company from the beginning of this month. He will take care of the company's interest in the middle and western states.

MR. WILLARD L. CANDEE of the Okonite Company left New York city on Wednesday of last week to be present at the laying of the land lines by the Commercial Pacific Cable Company of the Pacific cable in San Francisco and Honolulu.

MR. CHARLES A. TREMERE, former president of the Florida Electric Company, was a recent visitor to New York city. Mr. Tremere is no longer connected with the Florida Electric Company, of Jacksonville, having sold out his interest to Mr. T. W. Dunk, of that city.

MR. EDWIN REYNOLDS, for many years general superintendent of the Edward P. Allis Company and chief engineer of the Allis-Chalmers Company, has been made the consulting engineer of the entire concern. Mr. Irving H. Reynolds has been advanced to the position of chief engineer.

NEW INCORPORATIONS.

DOVER, DEL.—The Queretaro Power Company. $300,000.

HURON, S. D.—Gladys Electric Light, Water and Power Company. $100,000.

HATTIESBURG, MISS.—Hattiesburg Light and Power Company. Incorporators: M. Hemphill, R. H. Hemphill, H. A. Hemphill.

FORT WORTH, TEX.—Quanah & Mangum Telephone Company. $5,000. Incorporators: M. M. Hankins, J. E. Woolbright and M. R. Smith.

SPRINGFIELD, ILL.—Citizens' Light and Water Company. $70,000. Incorporators: A. R. Manley, P. G. Manley and J. M. Mitchell.

CHATTANOOGA, TENN.—The Chattanooga Light and Power Company has been awarded a contract for city lighting for a period of two years.

JERSEY CITY, N. J.—Davis Electric Manufacturing Company. $50,000. Incorporators: Raymond Newman, Horace S. Gould and K. K. McLaren.

ALTOONA, PA.—The Citizens' Electric Light Company. $1,000. Directors: Daniel G. Owens, John M. Hamer, Tyrone; Charles W. Hooner, Bellwood.

MINNEAPOLIS, MINN.—The Electric Machinery Company. $125,000. Incorporators: James T. Bousted, Charles H. Chalmers, William J. Lau.

GUTHRIE, O. T.—The Temple Power, Water, Light and Fuel Company. $25,000. Incorporators: E. J. Kelly, of Waurika; O. C. French and B. V. Cummins, of Temple.

UTICA, N. Y.—The Crescent Electric Company. $30,000. Incorporators: William P. Campbell, J. C. Eichmeyer, A. J. Potter, William H. Pryor, Jr., and John Wenzel.

PIERRE, S. DAK.—New England Light and Fuel Company. $100,000. Incorporators: Dexter M. Small, Robert L. Stanton, Providence, R. I.; L. L. Stephens, South Dakota.

ALBANY, N. Y.—The Almstead-Gough Electric Company. $10,000. Directors: Ezra M. Higgins, Morris J. Almstead, of Rochester, and Albert H. Ellis and William H. Gough, of Syracuse.

ELECTRIC RAILWAYS.

MONTGOMERY, ALA.—Work on the Opelika & Auburn electric railway has been begun and will be pushed rapidly. The expenditure contemplated at once is $200,000.

TRENTON, N. J.—Work is to be commenced at once on the Johnson Company's Princeton extension, from the north, and the Camden Traction Company, from the south.

FREEPORT, L. I.—The New York & Long Island Traction Company is arranging to extend its lines to Baldwin, Ocean Side, East Rockaway and Lynbrook, and work will begin soon.

FORT WORTH, TEX.—The Northern Texas Traction Company will spend $200,000 improving its lines in this city, and will ultimately build extensions to Denton, Cleburne and Weatherford.

OSWEGO, N. Y.—The Hudson River Power and Transmission Company is about to erect a large substation at Alpaus, at the point where the wire from Spier's Falls connects with the wire from Mechanicsville dam.

CINCINNATI, OHIO—The Terminal Traction Company has been incorporated with a capital of $100,000, to build a central station in Cincinnati for the electric lines from different parts of Ohio and to provide suitable terminals.

WILMINGTON, N. C.—Work has been commenced on the new power-house for the Consolidated Railways. It will be a modern building of brick and will be completed and equipped ready for operation by the middle of January.

HACKENSACK, N. J.—The Hudson River Traction Company, which operates the trolley lines between Fort Lee, Englewood and Hackensack, has secured control of the Newark & Hackensack trolley line, and will at once assume the management of that road.

MILWAUKEE, WIS.—The Milwaukee Electric Railway and Light Company has been granted a fifty-year franchise covering about five miles of road, extending from the eastern part of the town of Lake to the western limits. The new line will be built at once.

BANGOR, ME.—The survey of the proposed electric road to connect the Augusta, Winthrop & Gardiner road at Togus with the Rockland, Thomaston & Camden road, has been practically completed. It is intended to build the road next spring. It will be thirty miles in length.

ROANOKE, VA.—S. D. Furguson, of this city, and E. M. Funkhouser, of Staunton, Va., have completed the purchase of the Staunton street railway, electric light and gas plants from Messrs. Sullivan and Cromwell, attorneys for the Seventh National Bank, of New York, the consideration being $250,000.

FRANKLIN, N. H.—The Pemigewasset Power Company, recently incorporated under the laws of the state of Maine, has purchased the property at Eastman Falls. The dam being constructed at this point will develop a heavy water power, and several concerns are understood to be negotiating for locations.

WILMINGTON, DEL.—The Cherry Hill, Elkton & Chesapeake City Electric Railway Company has been reorganized, and has bought a private right of way from Stanton, Del., to Newark and the Maryland line, combining with the Wilmington Street Railway Company for the use of its line from Stanton to Wilmington.

NASHVILLE, TENN.—The promoters of the Nashville & Gallatin and Nashville & Columbia electric railroads expect to have the lines built and in operation by spring. The surveys for the roads are about completed, and it is expected that contracts will be let within thirty days. Construction will begin as soon as possible.

WEST GROVE, PA.—The West Chester Street Railway Company has been granted a right of way through this town by the borough council. This company is building a belt line around Chester County, covering sixty-four miles and taking in Kennett, Anndale, West Grove, Oxford, Parkesburg, Coatesville, Downington and West Chester.

BALTIMORE, MD.—The Virginia Passenger and Power Company, which has become the owner of the Richmond & Petersburg Electric Railway, which now runs from Petersburg to Manchester, about twenty-two miles, intends to run cars through from Petersburg to Richmond, and in order to do so will either make improvements to the Free Bridge over the James River, or build a new bridge.

OSWEGO, N. Y.—President W. Judson Smith, of the Syracuse, Lakeside & Baldwinsville Railroad, states that his company will build a line to Oswego early in the spring, and that arrangements are progressing toward getting rights of way, franchises, etc. The road will run from Baldwinsville to West Phœnix, Oswego Falls, Minetto and Oswego. The distance from Baldwinsville to Oswego is twenty-five miles.

KNOXVILLE, TENN.—The Cleveland & Ducktown electric road, which has been chartered, is under the control of Chattanooga parties who have had the water power of the Ocoee River investigated to arrive at the horse-power to be secured. The project is to furnish power from this river to that part of the line east of Chattanooga, and power to be developed from the Caney Fork River will operate the road west of Chattanooga.

SALT LAKE CITY, UTAH—An electric road will be built between Cisco and Moab at an early date for the purpose of transporting ore from the latter point to the Rio Grande Railroad at Cisco. It will be about fifty miles long, and will cost about $1,000,000. It may also be extended to La Sal mines, across the Colorado border, fifty miles from Moab. The company is composed entirely of Utah capitalists, with headquarters at Provo and Salt Lake City.

KALAMAZOO, MICH.—H. E. Bucklen, of Chicago, is to build an electric line connecting Elkhart and Valparaiso. The line will ultimately be extended to Angola, which is near the Ohio state line, and where connection will be made with a projected line that will establish continuous connection between Chicago and Toledo. Franchises have been secured and partial surveys of the route have been made. The capital is said to be available for immediate use.

TISHOMINGO, I. TER.—It is stated that a company, backed by eastern capital, will build an electric road connecting Denison and Tishomingo. The road will be forty-five miles in length, and will carry freight as well as passengers. The company will build a dam across the Pennington River, just above Tishomingo, by this means securing 1,000 horse-power, which will be sufficient to run the trains and for lighting purposes in towns between Denison and Tishomingo, and also Tishomingo.

CRESTON, IOWA—The Creston Railway, Heat, Light and Power Company has filed with the recorders of Union and Adair counties a trust deed for $600,000, conveying to the Trust and Loan Company all of the property of the company and any more to be acquired, and giving the trust company first mortgage on all present or acquired amounts of the company. The deed was made to secure the issuance of 5,000 bonds, of $100 each, the money so acquired to be used for the construction of the road at a cost of not more than $15,000 per mile. The building of the road will be begun as soon as possible.

SPOKANE, WASH.—A deal has just been completed for the organization of the Cœur d'Alene & Spokane Railway Company, Limited, with a capital stock of $500,000. The directors announce that it is the intention to build an electric road between Spokane and Cœur d'Alene City. The road is to be financed by Cœur d'Alene lumbermen, and the work of acquiring the right of way will be begun at once. The directors of the company are: F. A. Blackwell, of Williamsport Pa.; William Dollar, of Cœur d'Alene City; A. Bettes, of Detroit, Mich.; C. P. Lindsley, of Menominee, Mich., and F. S. Robbins, of Rhinelander, Wis.

JANESVILLE, WIS.—The Janesville Electric Company, owner of the local lighting plant, has passed into the hands of a company composed of Stanley B. Smith, Levy B. Carte, George G. Sutherland, M. G. Jefferies, T. O. Howe and P. H. Korst. The company is to be entirely reorganized and the capital stock increased from $30,000 to $100,000. The plant will be largely increased, and besides furnishing lighting and heating will also furnish electric power to factories. The company which purchased the plant is composed of the same men who recently came into possession of all the valuable properties and water rights of the Janesville Cotton Mills Company, and they now own practically all of the first water rights of Rock River. The company will file its amended articles and elect new officers at once.

ELECTRIC LIGHTING.

ST. LOUIS, MO.—The city council has passed the ordinance appropriating $33,000 for the establishment of an electric lighting plant in the basement of the new city hall.

MONTGOMERY, W. VA.—Word has been received here of the burning of the power-house at the Kaymoor coal mines. It is estimated that the damage will not fall short of $50,000.

SCHENECTADY, N. Y.—It is reported that a number of the leading business men of Schenectady have under consideration the organization of an electric lighting company on the cooperative plan.

NIAGARA FALLS, N. Y.—Active work has been begun on the plant of the Niagara Falls Hydraulic Power and Manufacturing Company. The work will take years, and many men will be employed.

CAPE MAY, N. J.—All the contracts for the erection and construction of the new electric light plant for the Cape May Light, Heat and Power Company have been awarded, and the work will soon be under way.

CRYSTAL FALLS, MICH.—Plans are under way for greatly improving the municipal lighting plant. A water-power canal is being constructed that will furnish much greater energy than the present steam plant.

ASHTABULA, OHIO—It is reported here that $50,000 will be expended at once in installing an electric plant on the Pennsylvania docks in this city, to be used in operating the mammoth ore and coal-handling machines.

HUNTINGTON, N. Y.—The Huntington Light and Power Company has made arrangements to begin operations at once on its plant here. The incorporation has been completed, and a first-class plant is to be erected.

CINCINNATI, OHIO—A deal has been closed by which the property of the Wyoming Electric and Power Company has passed into the hands of the Cincinnati Gas and Electric Company. The purchase price has not been made public.

TRENTON, N. J.—Charles A. Comp and C. A. Budd, of Yardville, and Augustus Wolf, of Chambersburg, Pa., have incorporated the Yardville Electric Light, Heat and Power Company, with a capital stock of $25,000. The company is to do a general electric business.

JAMESTOWN, N. Y.—The board of public works has recommended the building of a $40,000 addition to the lighting plant. It is estimated that if the plant's capacity is increased the revenue from commercial lighting would be sufficient to operate the entire plant without any direct tax for street lighting.

JORDAN, MINN.—A local company, named the Jordan Electric Light and Heating Company, has been incorporated for the purpose of furnishing light to this city, and work has already commenced. The officers of the company are: C. H. Casey, president; H. S. Shreiner, vice-president; G. F. Schmitt, secretary; H. F. Juergens, treasurer.

EASTON, PA.—The Easton Power Company, the Easton Gas Company, the Easton Gas Fuel Company and the Delaware Gas Light Company will be consolidated, and the name of the new company will be the Easton Gas and Electric Company. It is stated that the merger will not make any material changes in the officials of the different companies.

BOSTON, MASS.—Joseph P. Bass, Bangor, who a year ago purchased all the stock of the Oldtown Electric Light Company and the Oldtown Gaslight Company, has sold these properties to the Public Works Company, of Bangor. Four new directors have been elected, as follows: John R. Graham, F. D. Oliver, James H. Cutler and James N. Cartwright. The Public Works Company will make many improvements.

YORK, PA.—Charters for the Long Island Water and Power Company and for the Shenk's Ferry Water and Power Company have been recorded here. They are both located in this county and are part of the big system being installed in the lower end to develop electric power. The directors of both are the same: Albert L. Register, Ardmore, Pa.; John DeW. Duncan, Philadelphia, and George M. Bunting, Chester, Pa.

TELEPHONE AND TELEGRAPH.

DANBURY, CT.—The Southern New England Telephone Company is making extensive improvements to its local exchange.

LE ROY, N. Y.—The Inter-Ocean Telephone Company is securing rights for placing its poles in this village, and it is expected that construction will begin soon.

ATLANTA, GA.—Work on the erection of the new annex for the Southern Bell Telephone Company has been begun, and it is expected that everything will be completed within four months.

JACKSON, MINN.—The Jackson Telephone Company has been incorporated by C. A. Sterling, of La Crosse, Wis., and Paul H. Berge, Hans Sether, George R. Moore and Thomas Knox, of Jackson, with a capital of $650,000.

HOPKINSVILLE, KY.—The contract for the new exchange and office building for the Cumberland Telephone Company has been let, and work will be begun at once. The building will be thoroughly modern in every respect.

TROY, N. Y.—The Commercial Union Telephone Company has been incorporated to conduct a line connecting the cities and villages in the counties of Rensselaer, Saratoga, Washington, Warren and Essex, and the cities and villages in other counties in the state and adjoining states. The directors of the company are: John F. Christie, C. V. Collins and William C. Geer, all of Troy.

DAVENPORT, IOWA—The long-distance line of the American Telephone and Telegraph Company between Davenport and St. Louis has been opened for business. This is the line that was recently built from Davenport to St. Louis *via* Muscatine, Burlington, Keokuk, Fort Madison and Hannibal. It connects with the same company's line from Davenport to Chicago and the East.

OBITUARY NOTICE.

MR. JOSEPH M. WILSON, engineer and architect, died suddenly in his office in Philadelphia on the afternoon of November 24. Mr. Wilson was born in Phoenixville, Pa., in June, 1838. He was educated at the Rensselaer Polytechnic Institute, Troy, N. Y., graduating in 1858. In 1860 he became assistant engineer of the Pennsylvania Railroad. In 1863 he was made resident engineer of the Middle Division, and from 1865 to 1886 he held the post of engineer of buildings and bridges. In 1876 Mr. Wilson was associated with the designing and construction of the main exposition building and machinery hall of the Centennial Exposition. He served on the commission that condemned the Washington Aqueduct and that recommended the underground railway system now being constructed in New York city. He was president of the Franklin Institute for a number of years, was a member of the Engineers' Club, of New York city; the Institution of Civil Engineers, of London, the American Society of Civil Engineers, the American Philosophical Society, was a fellow of the American Association for the Advancement of Science, and a fellow of the American Institute of Architects. His wife and one married daughter survive him.

INDUSTRIAL ITEMS.

THE HEINE SAFETY BOILER COMPANY, St. Louis, Mo., recently supplied to the East St. Louis & Suburban Electric Railroad a 5,000-horse-power boiler.

THE THOMAS S. CLARKSON MEMORIAL SCHOOL OF TECHNOLOGY, at Potsdam, N. Y., held its founder's day exercises on Monday evening, December 1.

THE ECCLESTON LUMBER COMPANY, 29 Broadway, New York city, ships promptly direct from its own mills. This company makes a specialty of yellow pine ties, poles and cross-arms. The fall business has been very gratifying, and the company has ready for immediate use a special lot of carefully inspected material.

THE NATIONAL ELECTRICAL SUPPLY COMPANY, Washington, D. C., owing to the greatly increased demand for its supplies, has found it necessary to enlarge its establishment, and the company has just finished the addition of another story to its present quarters. This company carries a full line of electrical supplies and specialties.

THE WESTERN TELEPHONE MANUFACTURING COMPANY is a new Illinois corporation which is taking over all the patents

belonging to the Western Telephone Construction Company. This company has some strong men in its board of directors, and it is expected that it will become a strong factor in the telephone work of the West.

THE SIGNALOID CHEMICAL WORKS, 81 Fulton street, New York city, is the manufacturer of a patent chemical compound for frosting and coloring incandescent bulbs. The holiday trade is bringing a large demand for this class of material, and the Signaloid company is possessed of the best facilities for promptly executing orders of any magnitude.

THE EUREKA ELECTRIC COMPANY, Chicago, Ill., announces that in its headquarters, Room 656 in the Auditorium, will be found during the convention the latest apparatus manufactured by the company. The exhibit will be in charge of Messrs. I. J. Kusel, D. L. Canmann, H. Rosenow, C. W. Robbins, Paul Gardner and others. Handsome souvenirs will be given away.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., has placed on the market, under the name of the "Eaco dry battery," a piece of apparatus which has successfully stood severe tests to which it has been subjected to decide its usefulness. This company will be pleased to give full information to any one interested with regard to the life and service of this new battery.

THE NEW HAVEN NOVELTY MACHINE COMPANY, New Haven, Ct., will have an elaborate exhibit at the Auditorium Hotel during the convention of the Interstate Telephone Association in Chicago. Some of the notable apparatus which will be exhibited at this time will be the Novelty slidable sleeve, for splicing connections; the Novelty sleeve and Y-branch; sleeve and three-way branch, and pothead.

THE PORTER BATTERY COMPANY, Waukegan, Ill., is making large additions to its present plant. A second floor is to be added to the main building and other buildings will be erected. This change is made necessary by the rapid increase in the company's business and the fact that it is now taking up both railroad and stationary work. The company is installing a large plant in the Lessing Apartment Building, North Side, Chicago, Ill.

L. B. ALLEN COMPANY, INCORPORATED, Chicago, Ill., sole manufacturer of the Allen soldering stick, Allen soldering paste, Allen soldering salts and Allen commutator lubricant, reports that the volume of the business is constantly increasing, not only in the domestic, but in the foreign market as well. The company aims to make prompt shipments an important feature of its service, and its facilities are expected to make it rank very high in this regard.

THE ATLAS CAR MANUFACTURING COMPANY, Cleveland, Ohio, manufactures a very complete line of industrial railroad equipment. This includes mine cars, drier cars, coal and ore cars, and cars for rolling mill, blast furnace, smelting works, foundries and manufacturing plants; also switches, frogs, crossings, portable track, rail, steel ties, switch stands, etc. The company will be pleased to send full information to any one interested on request.

THE O. C. WHITE COMPANY, Worcester, Mass., manufacturer of standard adjustable fixtures for incandescent lamps, makes a specialty of apparatus which will throw the light in any direction and in any position where the maximum illumination is procured. This apparatus is made in a great number of styles which are illustrated in the handsome catalogue which the company publishes. This includes illustrations and descriptions of this apparatus with price lists for the different styles.

THE VEEDER MANUFACTURING COMPANY, Hartford, Ct., manufactures a number of counters, cyclometers, odometers and fine castings, and, while small, these are durable and simple. They are found especially useful on voting machines, telephones, nickel-in-the-slot machinery, and, in general, to register the number of pieces of material produced in a steady and reliable manner. A specialty is a small telephone counter which can be used either with automatic or manually operated exchanges.

THE NATIONAL PARK BANK OF NEW YORK, which has a large electrical clientele and is one of the great financial institutions of the city, has recently improved and enlarged its building at 214 and 216 Broadway. In addition, the Park Bank is identified with several other well-known banks in the city, including the Mount Morris Bank, the Mutual Bank, the Yorkville Bank and the Plaza Bank. Mr. Richard Delafield, president of the Park, is also chairman of the boards of directors of the several banks named. The other officers of the National Park Bank are: Vice-presidents, Stuyvesant Fish, Albert H. Wiggin and Gilbert G. Thorne; cashier, George S. Hickok; assistant cashier, Edward J. Baldwin.

THE EDISON ELECTRIC ILLUMINATING COMPANY, Brooklyn, N. Y., has begun the publication of a small leaflet to be called "The Brooklyn Edison." This will contain illustrations and short concise articles upon matters of general electrical interest. The first issue illustrates a section of the 40,000-light storage battery in the Pearl street station, New York, and several reproductions of window displays of prominent firms in Brooklyn. The next issue is to be devoted to the manufacturing, giving descriptions and illustrations of several of the largest power installations of the company and also outlining the numerous and varied uses to which electric motors are put. Mr. W. Jac Marland is the general agent of the Brooklyn company.

H. B. COHO & COMPANY, general sales agent of the Keystone Electric Company, reports recent sales of Keystone generators and motors to the following customers: American Hard Rubber Company, Butler, N. J., 50-horse-power motor, 10-horse-power motor; Ball Engine Company, Erie, Pa., 10 motors; Carnegie Coal Company, Carnegie, Pa., 175-kilowatt generator with switchboard; Clemson Brothers, Middletown, N. Y., 10-horse-power motor; Erie City Iron Works, Erie, Pa., 67-horse-power motor; Erie Forge Company, Erie, Pa., 25-kilowatt generator; Fischer Motor Vehicle Company, Hoboken, N. J., 5-kilowatt generator; Franklin Supply Company, Franklin, Pa., generator; Herbert Manufacturing Company, Erie, Pa., 15-kilowatt generator; Jones Brothers, proprietors Grand Union Tea Company, Brooklyn, N. Y., 30-horse-power motor, 20-horse-power motor, 15-horse-power motor, 10-horse-power motor special, two 5-horse-power motors, 7.5-horse-power motor; Leggett Brothers, New York, N. Y., 3-horse-power motor; W. C. McIntire & Company, Philadelphia, Pa., 200-kilowatt generator; Malleable Casting Company, Sharon, Pa., 5-horse-power motor; Mansfield Coal Company, Carnegie, Pa., 150-kilowatt generator; Masurite Explosive Company, Sharon, Pa., two 8.5-horse-power motors; Penn Boiler Works, Erie, Pa., switchboard; J. C. Stearns, Buffalo, N. Y., 5-horse-power motor; Union Ice Company, Erie, Pa., 30-kilowatt generator; United States Mint, Philadelphia, Pa., five special vertical motors; H. F. Watson & Co., Erie, Pa., 25-kilowatt generator; Watson & Stillman, 18.5-kilowatt generator. The Keystone Electric Company builds machines of large capacity, and has a number of specialties.

THE SPRAGUE ELECTRIC COMPANY, New York city, is receiving many orders for its direct-current apparatus and reports among recent sales the following: Twenty 200-kilowatt turbine generators, three 75-kilowatt generators and four 20-kilowatt generators to the De Laval Steam Turbine Company, Trenton, N. J.; one 200-kilowatt belted-type and one 200-kilowatt engine-type generators to H. O. Wilbur, Philadelphia; one 200-kilowatt engine-type generator to the Otis Elevator Company, Yonkers; one 200-kilowatt belted-type generator to W. D. Ewarts, Chicago; one 40-kilowatt and two 35-kilowatt belted-type generators to the Criterion Hotel, New York; one 75-kilowatt belted-type generator to C. Poyet, New York; one 50-kilowatt belted-type generator to the American Express Company, Chicago; two 3-horse-power round-type motors to the West End Theatre, New York; three 8-kilowatt generators, six 5-horse-power and four 1-horse-power motors to the Fisher Motor Vehicle Company, Hoboken, N. J.; one 40-horse-power medium speed motor to J. F. Perkins Company, Brooklyn, N. Y.; one 16-horse-power S. S. type motor to L. W. Pond Machinery and Foundry Company, Worcester, Mass.; one 40-horse-power belted-type motor to Miehle Printing Press Manufacturing Company, Chicago; two 20-horse-power M. S. type motors to the Sigourney Tool Company, Hartford, Ct.; one 17-horse-power S. S. type motor to the Martinique Apartment House, New York; two electric hoists to the Phœnix Iron Works, Phœnixville, Pa.; one electric hoist to Landis Tool Company, Geiser Station, Pa.; one electric hoist to the American Car and Foundry Company, Berwick, Pa.; one electric hoist to the Scranton Supply and Machinery Company, Scranton, Pa., and one electric hoist to Pond Machinery and Tool Company, Plainfield, N. J.; two electric hoists to Michigan Alkali Company, Wyandotte, Mich.